Biological Report 90(16)
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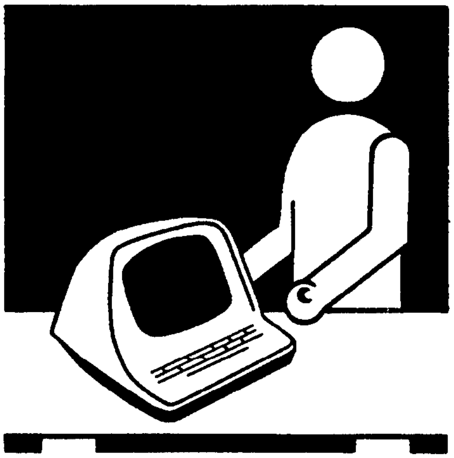
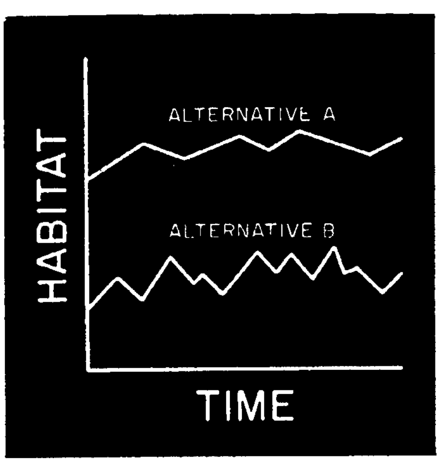
Reference Manual for Generation and Analysis of Habitat Time Series—Version II



Instream Flow

Information Paper 27



Fish and Wildlife Service

U.S. Department of the Interior

Biological Report

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Reference Manual for Generation and Analysis of Habitat Time Series—Version II

Instream Flow Information Paper 27

By

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Preface

The selection of an instream flow requirement for water resource management often requires the review of how the physical habitat changes through time. This review is referred to as "Time Series Analysis."

The Time Series Library (TSLIB) is a group of programs to enter, transform, analyze, and display time series data for use in stream habitat assessment. A time series may be defined as a sequence of data recorded or calculated over time. Examples might be historical monthly flow, predicted monthly weighted usable area, daily electrical power generation, annual irrigation diversion, and so forth. The time series can be analyzed, both descriptively and analytically, to understand the importance of the variation in the events over time. This is especially useful in the development of instream flow needs based on habitat availability.

The TSLIB group of programs assumes that you have an adequate study plan to guide you in your analysis. You need to already have knowledge about such things as time period and time step, species and life stages to consider, and appropriate comparisons or statistics to be produced and displayed or tabulated. Knowing your destination, you must first evaluate whether TSLIB can get you there. Remember, *data are not answers.*

This publication is a reference manual to TSLIB and is intended to be a guide to the process of using the various programs in TSLIB. This manual is essentially limited to the hands-on use of the various programs.

A TSLIB user interface program (called RTSM) has been developed to provide an integrated working environment where the user has a brief on-line description of each TSLIB program with the capability to run the TSLIB program while in the user interface. For information on the RTSM program, refer to Appendix F.

Before applying the computer models described herein, it is recommended that the user enroll in the short course "Problem Solving with the Instream Flow Incremental Methodology (IFIM)." This course is offered by the Aquatic Systems Branch of the National Ecology Research Center. For more information about the TSLIB software, refer to the Memorandum of Understanding.

Chapter 1 provides a brief introduction to the Instream Flow Incremental Methodology and TSLIB. Other chapters in this manual provide information on the different aspects of using the models. The information contained in the other chapters includes (2) acquisition, entry, manipulation, and listing of streamflow data; (3) entry, manipulation, and listing of the habitat-versus-streamflow function; (4) transferring streamflow data; (5) water resource systems analysis; (6) generation and analysis of daily streamflow and habitat values; (7) generation of the time series of monthly habitats; (8) manipulation, analysis, and display of monthly time series data; and (9) generation, analysis, and display of annual time series data.

Each section includes documentation for the programs therein with at least one page of information for each program, including a program description, instructions for running the program, and sample output.

The Appendixes contain the following: (A) sample file formats; (B) descriptions of default filenames; (C) alphabetical summary of batch–procedure files; (D) installing and running TSLIB on a microcomputer; (E) running TSLIB on a CDC Cyber computer; (F) using the TSLIB user interface program (RTSM); and (G) running WATSTORE on the USGS Amdahl mainframe computer.

The number for this version of TSLIB—Version II—is somewhat arbitrary, as the TSLIB programs were collected into a library some time ago; but operators tended to use and manage them as individual programs. Therefore, we will consider the group of programs from the past that were only on the CDC Cyber computer as Version 0; the programs from the past that were on both the Cyber and the IBM-compatible microcomputer as Version I; and the programs contained in this reference manual as Version II.

To obtain magnetic tapes or floppy disks of the TSLIB programs contact

TGS Technology
FWS–NERC Operations
P.O. Box 9076
Fort Collins, Colorado 80525
(303) 226-9413

For technical assistance with TSLIB programs, contact:

Support Services Branch
National Ecology Research Center
U.S. Fish and Wildlife Service
4512 McMurray Avenue
Fort Collins, Colorado 80525
(303) 226-9100

As errors are corrected, enhancements made, or new programs added to TSLIB, new versions will be released. Incremental changes may be available on the National Ecology Research Center computer bulletin board. Call (303) 226-9365 with no parity, 8 data bits, and 1 stop bit to download programs (See Section 9 in the Memorandum of Understanding).

Memorandum of Understanding
National Ecology Research Center

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This agreement, in compliance with the Freedom of Information Act (43 CFR, Part 2), serves as evidence of the mutual understanding governing the distribution and subsequent use of computer software developed by the National Ecology Research Center (NERC). The undersigned, as an independent individual or as the responsible official of the firm, institution, association, government agency, or other such group, agrees that all its members, affiliates, and employees shall abide by the conditions listed below. (Conditions 1 and 2 specifically apply to nongovernmental entities, including corporations, private individuals, and profit-making associations.)

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2. There shall be no operational support (including technical assistance) of software or documentation transferred from the NERC to a government entity unless specifically funded through a current fiscal year agreement, such as Project Study Plan, Interagency or Cooperative Agreement, or other appropriate arrangement. *The NERC cannot provide operational support to nongovernmental entities.*

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6. If the source code or documentation of NERC programs is transferred to a third party, a copy of this Memorandum of Understanding shall accompany those products, and the NERC shall be notified of the transfer. This notification shall include the name, address, and telephone number of the third party. Announcements of updates and releases of the NERC programs may be provided, at NERC's initiative, to all recorded users of NERC software. For purposes of this memorandum, "third party" refers to any physical host computer facility other than the one at the original recipient's location.

7. All documents and reports conveying information obtained as a result of the use of original NERC programs, by either recipient or third party users, shall acknowledge their origin as being the National Ecology Research Center,

Fish and Wildlife Service, United States Department of the Interior. If the programs have been modified and/or are no longer supported or maintained by the NERC, this status shall be stated in the acknowledgment. The recipient agrees to send a copy of each report or publication in which the software was used to the National Ecology Research Center.

8. The recipient understands that the acknowledgement of the National Ecology Research Center, U.S. Fish and Wildlife Service, shall not explicitly or implicitly be used to support the specific analysis, interpretations, or other findings of an application or study utilizing these computer programs.

9. When the recipient has signed and returned this document to the National Ecology Research Center, the recipient will be provided a telephone number (and password—if needed) for access to the electronic Bulletin Board system used to convey information concerning the status of this software.

______________________________ ______________________________

NERC Representative Date Recipient Signature Date

Please Print

Name: ______________________________

Company: ______________________________

Address: ______________________________

____

Telephone Number: ______________________________

Software Package received: ______________________________

Conversion Table

Multiply	By	To Obtain
Acres	43,560	Square feet
	4047	Square meters
	1.562×10^{-3}	Square miles
Acre-feet	43,560	Cubic feet
	325,851	Gallons
	1233.49	Cubic meters
Acre-feet/day	0.504	Cfs
Acre-feet/month	0.01656	Cfs (average)
Acre-feet/year	0.0013803	Cfs (average)
Cms	35.31	Cfs
Cubic feet	7.48052	Gallons
Cubic feet/minute	0.1247	Gallons/sec
Cubic feet/month	3.8×10^{-7}	Cfs
Cubic feet/second (Cfs)	0.646317	Million gallons/day
	448.831	Gallons/minute
	1.983	Acre-feet/day
	60.33	Acre-feet/month (average)
Cubic meters	35.31	Cubic feet
	264.2	Gallons
Cubic meters/month	1.343×10^{-5}	Cfs (average)
Day	86,400	Seconds
Degrees C + 17.78	9/5	Degrees F
Degrees F – 32	5/9	Degrees C
Feet	0.3048	Meters
Feet/second	1.097	Kilometers/hour
	0.6818	Miles/hour
Gallons	0.1337	Cubic feet
	3.785×10^{-3}	Cubic meters
Gallons/minute	2.228×10^{-3}	Cfs
	0.06308	Liters/second
	3.785	Liters/minute
	5,450.4	Liters/day
Hectares	2.471	Acres
	10,000	Square Meters
Hectometers	100	Meters
Hours	3,600	Seconds

Multiply	By	To Obtain
Kilometers	3,281	Feet
	10^3	Meters
	0.6214	Miles
Liters	0.03531	Cubic feet
	10^{-3}	Cubic meters
	0.2642	Gallons
Liters/minute	5.886×10^{-4}	Cfs
Meters	3.281	Feet
Miles	5,280	Feet
	1.609	Kilometers
Million gallons/day (MGD)	1.54723	Cfs
	0.043818	Cubic meters/second
Million gallons/month	0.05084	Cfs
Month (average)	2.6298×10^6	Seconds
Square feet	2.296×10^{-5}	Acres
	0.09290	Square meters
	3.587×10^{-8}	Square miles
Square kilometers	247.1	Acres
	10.76×10^6	Square feet
	10^6	Square meters
	0.3861	Square miles
Square meters	2.471×10^{-4}	Acres
	10.76	Square feet
	3.861×10^{-7}	Square miles
Square miles	640	Acres
	259	Hectares
	2.590	Square kilometers
Year (average)	365.25	Days
	8766	Hours
	3.15776×10^7	Seconds

Contents

Figures

Tables

Acknowledgments

We thank J. Richards, L. David, T. Taylor, and K. Ubowski who did an earlier version of program conversion and documentation. We also thank D. Crawford, D. Pondelek, and J. Shoemaker for their assistance with the graphic art and B. Heidebrecht for typing the equations and other formatting assistance.

Chapter 1.
Introduction

Time Series Analysis

The premise of time series analysis is that the instream physical habitat at a given time and place can be calculated as a function of the streamflow using the equation

$$HA(t) = PH(Q(t))$$

where

PH( ) is the physical habitat-versus-streamflow function for a given life stage and species of aquatic organism or river activity;
$Q(t)$ is the streamflow at time t; and
$HA(t)$ is the habitat area for time t.

The physical habitat represents the space in a river that can be used as habitat by a given species and life stage of fish. The assumptions and calculation procedures used to determine the physical habitat are described in Stalnaker (1979). The Time Series LIBrary (TSLIB) of programs has been developed to analyze the pattern of time-varying events.

The TSLIB system can be considered a decision support system with the decision being quantification of an instream flow need, an instream flow water right, or a minimum flow requirement for operation of a water resource project. The general concept of a decision support system using TSLIB is shown in Fig. 1.1; the objective is to choose between water resource management alternatives or to modify the operation of an existing water resource system.

A system has been developed to simulate the physical habitat as a function of streamflow: the Physical HABitat SIMulation system (PHABSIM), described in Milhous et al. (1989). If PHABSIM is used to generate the habitat-versus-streamflow function, then the physical habitat is called Weighted Usable Area and $PH(t) = WUA(\ )$, where WUA( ) is the weighted usable area versus streamflow function.

Time series requires two types of data—streamflow data and the habitat-versus-streamflow function. The use of the TSLIB programs does not require that PHABSIM be used to generate PH( ), but it does require that the PH( ) function exist and be credible. An example of the PH( ) function (generated using PHABSIM) is shown in Fig. 1.2.

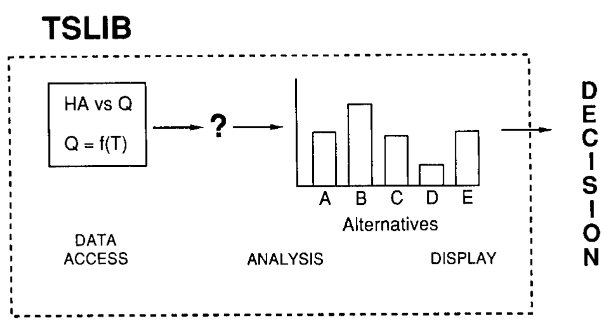
A streamflow time series has elements that are the volume of water flowing past a point divided by the time in the period. For example, the White River at Petersburg, Indiana, had a flow of 3,905 ft^3/s during one month (1.0460×10^{10} ft^3 in 2,678,400 s) or 239,700 acre-ft per month. In this manual, the average in cubic feet per second over the period is usually used.

The streamflow time series is used to develop a physical habitat time series. The results of using the habitat relation for adult rainbow trout and monthly streamflow for the Snoqualmie River are illustrated in Fig. 1.3. A comparison of the streamflow time series to the habitat time series proves the following two principles, which tend to be true in many regions and for many species:

- The physical habitat time series is less variable than the streamflow time series; and
- There are some streamflows where a moderate reduction in streamflow during some times of the year can result in a large reduction in physical habitat (e.g., compare August 1973 to August 1972).

Annual physical habitat values can be obtained from the monthly habitat values. The annual values for adult rainbow trout in the Snoqualmie River are illustrated in Fig. 1.4. In this case, the annual value for adult physical habitat in Fig. 1.4 is the minimum monthly habitat available during the water year.

The concept advanced by Milhous (1983) is that a physical habitat-versus-streamflow function can be used as a surrogate for an economic production function. In treating the physical habitat-versus-streamflow function as surrogate production function, the assumption is made that the value of the instream flows is proportional to the habitat produced by the flows. As with other economic benefits, it is desirable to know the time series of the benefits produced.



Figl.1. Concept of a decision support system using TSLIB.

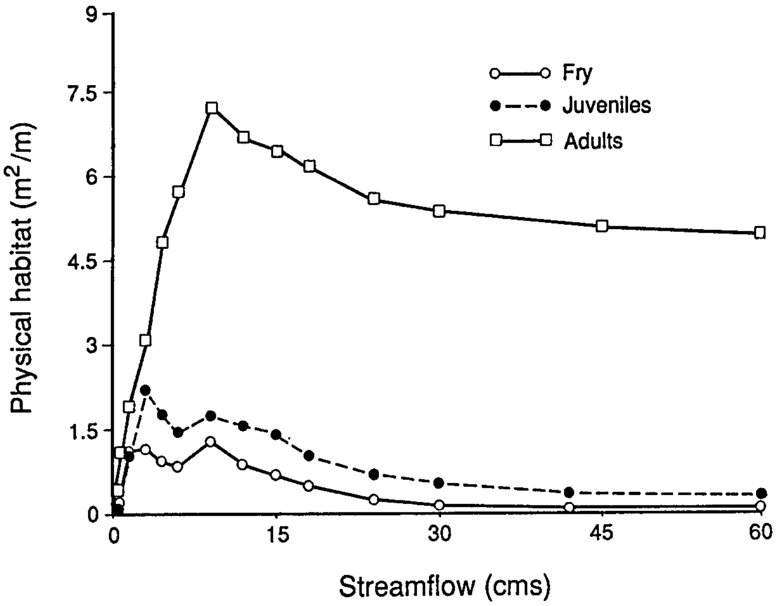


Fig. 1.2. The physical habitat for rainbow trout in the North Fork Snoqualmie River, Washington (1 ft^2/ft = 0.305 m^2/m; 1 cfs = 0.028 m^3/s).

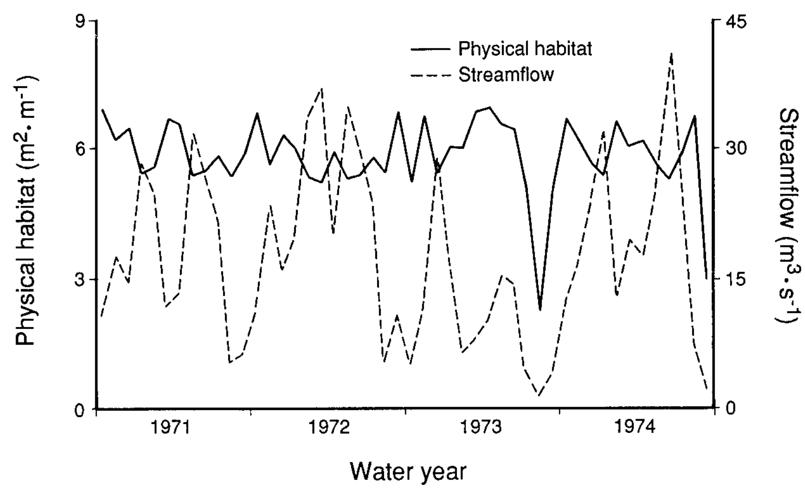


Fig. 1.3. Monthly streamflow and physical habitat for adult rainbow trout, 1971–74, in the North Fork Snoqualmie River, Washington (1 ft^2/ft = 0.305 m^2/m; 1 cfs = 0.028 m^3/s).

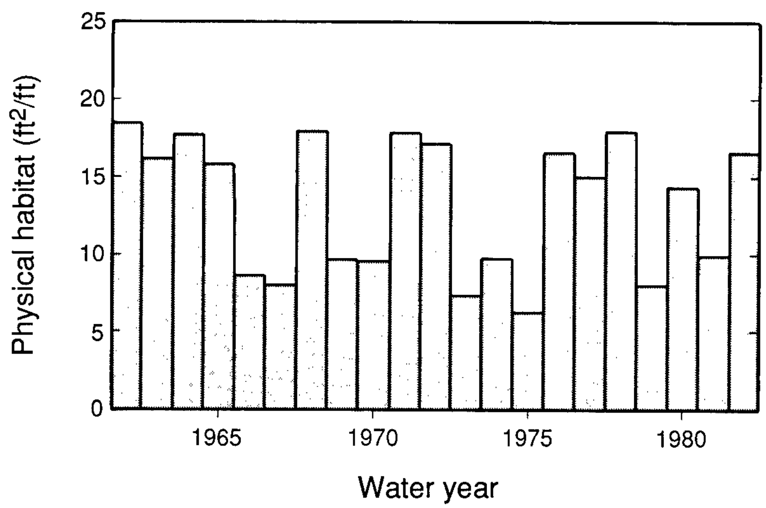


Fig. 1.4. Annual physical habitat for adult rainbow trout in the North Fork Snoqualmie River, Washington (1 ft^2/ft = 0.305 m^2/m; 1 cfs = 0.028 m^3/s).

Time Step

The choice between a daily or monthly time series analysis depends on the objective of the analysis and on the data and funds available. For example, daily values could be used for a gaged site and where the water resource system is being simulated using daily flows. In contrast, monthly streamflows would be used for a location with few streamflow measurements and where the streamflow record was synthesized by regression with nearby sites. Usually a time series of daily habitat is transformed to an index of monthly habitat for further analysis. The monthly habitat values are often transformed to some type of annual habitat index, which is (in most situations) the actual decision variable. The exception to this general pattern is where dual habitats are being considered in the analysis—in that situation, the annual index is developed directly from annual values of streamflows.

Average monthly data were used to generate the time series of physical habitats in Fig. 1.3. If daily flows were used and the results averaged to arrive at the average monthly habitat values, the results would not be the same. In addition, a linear interpolation procedure was used to develop the results in Fig. 1.3; a nonlinear procedure would have resulted in different values. A comparison of the habitat values for one year, obtained by using the different possible generation procedures, is included in Table 1.1. The differences are not large for the North Fork Snoqualmie River; however, they still illustrate the importance of using the same transformation procedure when comparing data sets such as for pre- and postproject conditions.

In most situations, a time series of daily streamflows would be the most appropriate; unfortunately, there are few situations where both a pre- and a postproject time series of daily streamflows is available. *Never* compare postproject habitat using one time step and preproject habitat using another time step. If this is done, a major error will have been made. There are few cases where daily habitats mean anything, because the biological system does not respond to daily conditions but to some integration of conditions over time. (The exceptions to this may be extreme events, such as peak flows.)

Organization of TSLIB

The flow of information through TSLIB is illustrated in Fig. 1.5. At first glance, Fig. 1.5 is overwhelming, but Figs. 1.6 through 1.8 are a breakdown of each step. Figure 1.6 illustrates the need to first obtain a habitat-versus-streamflow function and streamflow data. The next step is to transform the time pattern of streamflows to a time pattern of habitats. The analyst must then decide if the analysis of the resulting habitat time series is to be done using monthly data or to use annual data—or, in some situations, both. TSLIB is no more complex than the analyst chooses to make it. A goal in the design of TSLIB is to make it possible for the user to design an approach to a problem and not be constrained by another analyst's simplifying assumptions. It is possible to use either monthly or daily streamflow data—the choice of a time step will be discussed later.

Table 1.1. *Comparison of the habitat values that resulted from different habitat generation procedures for adult brown trout* (Salmo trutta) *in the North Fork Snoqualmie River, Washington.*

Month	Daily streamflows	Monthly streamflows	
	Linear (ft^2/ft)[a]	Linear (ft^2/ft)[a]	Nonlinear (ft^2/ft)[a]
October 1972	15.9	17.5	17.8
November 1972	19.2	22.6	22.6
December 1972	18.1	18.1	18.0
January 1973	21.0	20.8	20.8
February 1973	19.0	20.2	20.4
March 1973	21.7	22.9	23.2
April 1973	22.1	23.2	23.5
May 1973	21.4	21.3	21.3
June 1973	21.4	21.6	21.6
July 1973	15.7	17.0	17.2
August 1973	7.4	7.4	7.4
September 1973	11.4	15.7	15.8

[a] 1 ft^2/ft = 0.305 m^2/m.

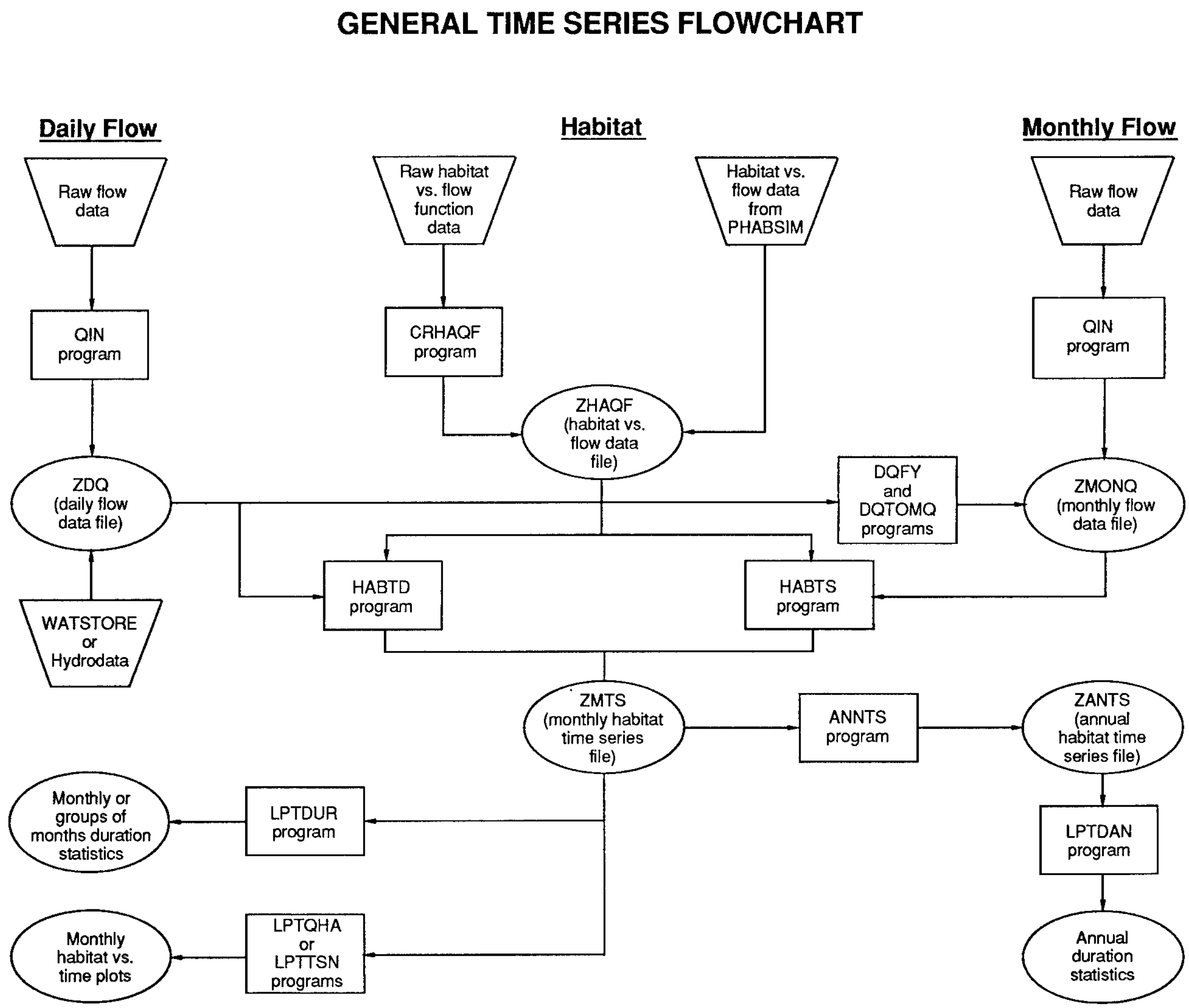


Fig. 1.5. Flow of information through the TSLIB programs.

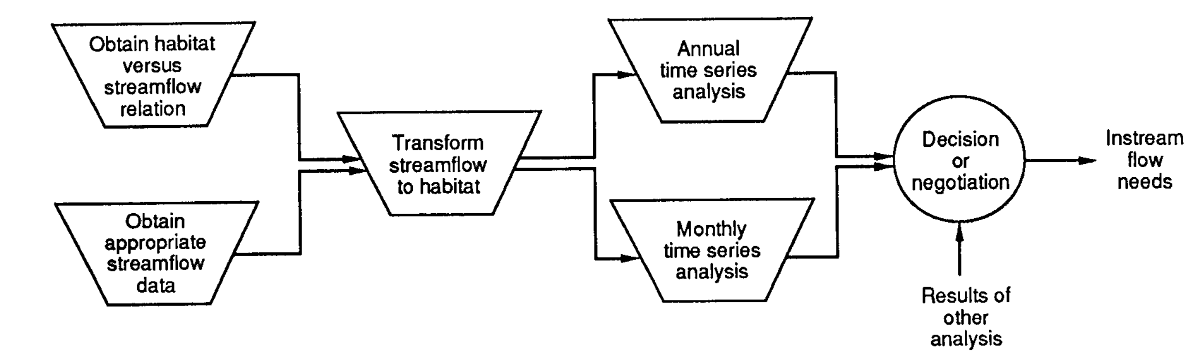


Fig. 1.6. TSLIB in its simplified form.

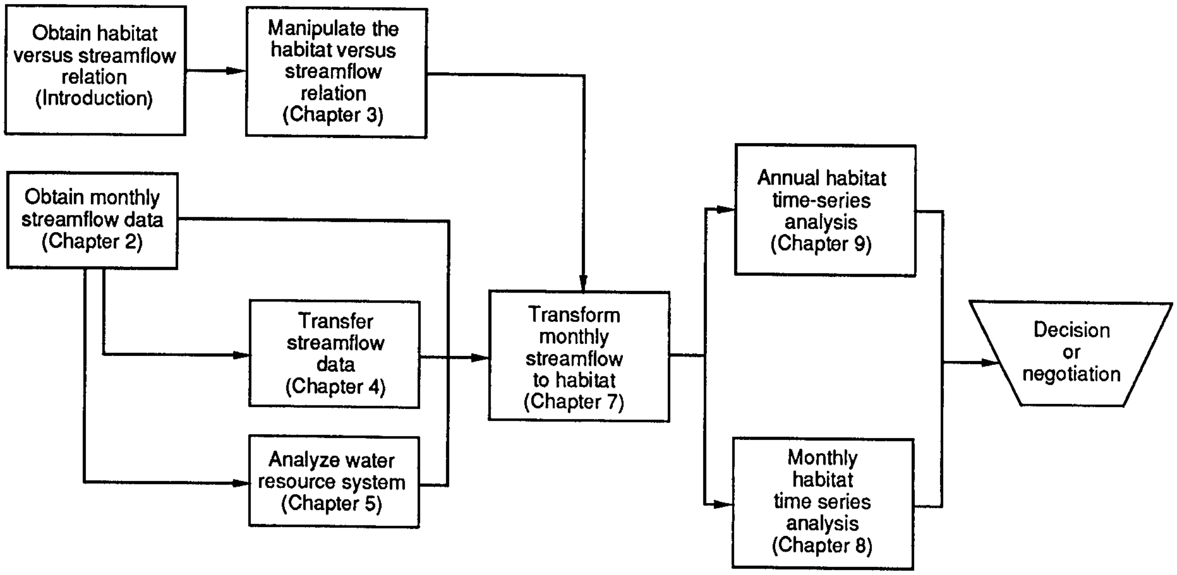


Fig. 1.7. Analytical path when monthly streamflow data are used.

The next level of complexity is illustrated in Fig. 1.7 for the use of monthly streamflow data. The diagram is similar to Fig. 1.6 except for the addition of programs that allow the user to transfer streamflow data either as an operations study of a reservoir or to develop streamflows at ungaged sites. The added programs all work with monthly time-steps.

Figure 1.8 is the same level of complexity as Fig. 1.7, except that daily time steps in streamflows are used, as opposed to monthly time steps. The resulting habitat time series may either be daily or monthly at the option of the user. To use TSLIB to analyze the time series, the results from the transformation of the streamflow data to physical habitat must be a monthly habitat time series. For daily habitats, the user must supply the programs or perform the analysis by hand.

Organization of the Manual

Chapter 2 of this manual presents programs to acquire, enter, manipulate, and list streamflow data. Sources for stream measurements include the Soil Conservation Service, the U. S. Geological Service (USGS) National Water Data Exchange (NAWDEX), the USGS National Water

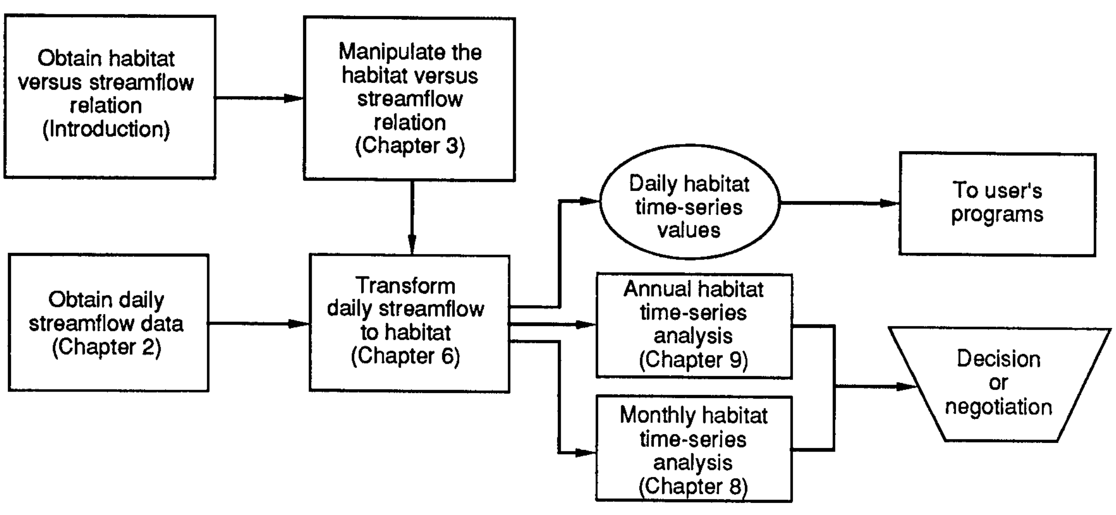


Fig. 1.8. Analytical path when daily streamflow data are used.

Data Storage and Retrieval System (WATSTORE), the Environmental Protection Agency's STORET, water conservation or irrigation districts, national parks and forests, city water departments, and private firms.

Information on the entry and manipulation of the habitat-versus-streamflow function is presented in Chapter 3. Users of TSLIB are responsible for obtaining a credible physical habitat area-versus-streamflow function for each life stage and species to be analyzed. This function may be output from the habitat simulation programs in the Physical Habitat Simulation System (PHABSIM) or can be entered directly by the user. The programs presented in Chapter 3 are intended to help the user display the habitat area-versus-streamflow function in different ways and to manipulate the function with a goal of better understanding the nature of the system being analyzed.

In many instream flow investigations, the site where the analysis is desired is not at the same location as where streamflow data are available. Usually it is the responsibility of the project sponsor to transfer the streamflow data from the location where information is available to the site where the instream flow analysis is desired. In some situations, the instream flow analyst needs to do the transferring. The programs presented in Chapter 4 allow the instream flow analyst to make relatively simple transferrals. Users interested in more complex approaches should contact experts in the area or develop their own programs.

The objective of many instream flow studies is to compare various water management schemes. These schemes may include both structural and nonstructural considerations: Structural considerations include the sizes and locations of reservoirs and diversions; nonstructural considerations are the rules for the operation of the reservoir at the diversion. Usually, the analysis of the water resource system will be done by the sponsoring agency or group, and the streamflows for the various operational alternatives will be made available by the sponsor. The instream flow analyst will (or at least should) be involved in the selection of some of the alternatives (always be wary of choosing the best from among a set of poor alternatives). The instream flow work then proceeds through the various time series analysis using the sponsor's streamflow (management) alternatives—there is no need for the instream flow analyst to do any water resource systems analysis.

Occasionally, the need does arise for the instream flow analyst to do an analysis of the water resource system. Usually this is due to the sponsor refusing to study viable alternatives or having limited ability to do a water resource systems analysis. The programs presented in Chapter 5 are fairly simple water resource systems models that can be used for the analysis in many water resource systems with which the instream flow analyst comes into contact. For more complex systems, the analyst should consider using programs available from the Bureau of Reclamation or the U.S. Army Corps of Engineers, as well as programs available from other groups.

The time series can be generated using one of two time steps—daily or monthly. The programs used to generate a daily time series of habitats are discussed in Chapter 6. Since the only programs available to review daily habitat values either simply display the values or transform the daily values to a monthly index, these analysis programs are included in Chapter 6. The program that goes directly from a duration curve of streamflow to a duration curve of physical habitats—called DQDUR—is also included.

Chapter 7 consists of information on programs used to generate the time series of monthly habitats. The HABTS program is the foundation for generating monthly habitat time series data for a single river segment; the HABNET program performs the same function for a stream network.

The monthly streamflow and physical habitat values by themselves give little information until they are analyzed and the results displayed. The programs presented in Chapter 8 are used to manipulate, analyze, and display the monthly time series data. In many situations, this should be considered an intermediate step before proceeding to the generation of an annual time series.

In many instream flow analyses, the time series of annual habitats is the most useful. The programs used to generate a time series of annual habitats from the monthly time series of physical habitats are discussed in Chapter 9. There are three approaches to using annual habitats: (1) The use of the annual adult habitat time series for each life stage assumes that the time series for adults represents the year-to-year variation of the worth of the stream for a species of aquatic animal; (2) the use of the annual *equivalent* adult habitat time series assumes that each year is independent of the preceding year but that each life stage must be considered; and (3) the use of annual *effective* adult habitat time series does not assume that each year is independent of the preceding year.

Summary

The TSLIB library is a collection of programs that allow the user to design an approach to time series analysis. There are programs to assist in the manipulation of the time series of streamflows and the physical habitat-versus-streamflow function. At the heart of the library are the programs that transform the streamflow time series to a physical habitat time series. The first two sets of programs are those that analyze a monthly time series or an annual time series of habitats.

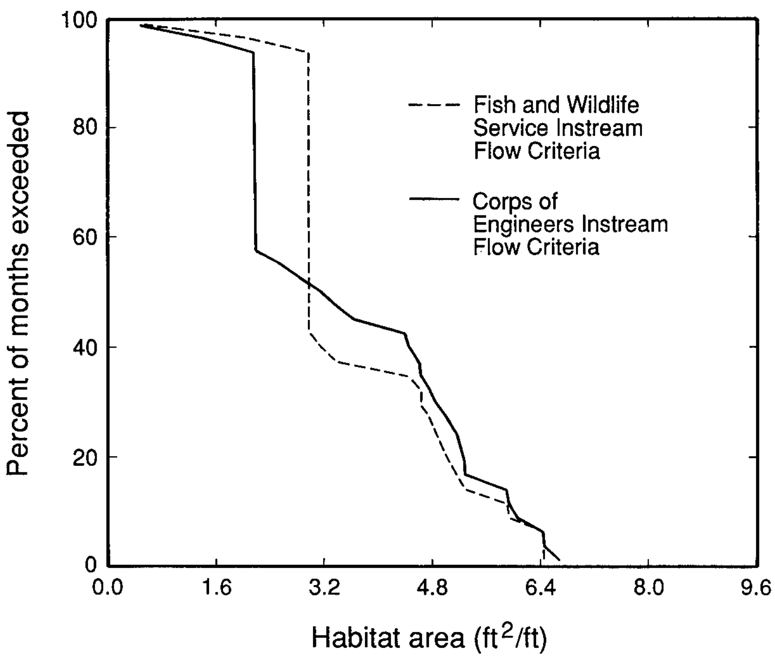


Fig. 1.9. Comparison of physical habitat in June for adult channel catfish in the Maraie des Cygnes River below Melvern Reservoir, with alternative instream flow criteria and 30 cfs diversion (1 ft^2/ft = 0.305 m^2/m).

A principle use of the monthly physical habitat time series is to compare alternative water management schemes. One approach is to compare duration curves (Fig. 1.9). The duration curves for alternative projects or water allocation rules can be compared to help select the best overall alternative. The specific comparison in Fig. 1.9 is of two alternative instream flow criteria, one proposed by the U.S. Fish and Wildlife Service and the other by the U.S. Army Corps of Engineers.

For additional information on the use of the monthly time series of physical habitat, see Bovee (1982: Chapter 5).

Chapter 2. Acquisition, Entry, Manipulation, and Listing of Streamflow Data

Introduction

Streamflow data for many rivers may be obtained from the U.S. Geological Survey (USGS), which maintains a network of gaging stations throughout the United States. Normally gages are located on the larger streams and rivers and may not be available in smaller watersheds. Typically, the streamflow measurements will reflect mean daily or mean monthly flows; further manipulations would be required for any other time-step. Sources for stream measurements include the Soil Conservation Service, the USGS National Water Data Exchange (NAWDEX), the USGS National Water Data Storage and Retrieval System (WATSTORE), the Environmental Protection Agency's STORET, water conservation or irrigation districts, national parks and forests, city water departments, and private firms.

Recently Earthinfo, a private firm, has gained some prominence in supplying a variety of environmental libraries of time series data on compact disk read only memory (CD-ROM) for personal computers. Among their offerings is a copy of the USGS WATSTORE data base called Hydrodata, which includes daily values, peak values, remarks, and quality of water. Another product, Climatedata, includes an extensive data base of air temperatures useful for water temperature modeling. Finally, Earthinfo offers products we have not investigated, such as Canadian surface water data and Colorado water rights tabulations.

Earthinfo data bases come with a variety of fairly straightforward software to search, extract, and convert the required data to formats necessary as input to TSLIB programs. They can also supply additional software for commonly used statistical and analysis techniques (at additional cost). In essence, if you can access Hydrodata, you can eliminate learning about the USGS's Amdahl, a microcomputer communications package, and the TSLIB programs DAILY, DURTBL, GETREL, INVENT, MESS, PEAK, and PAGEBR. These will be replaced by equivalent, but mostly simpler, functions in the Earthinfo software.

This manual concentrates on the use of WATSTORE, as it is a public data source; however, we encourage you to look into Earthinfo. We have found that the Earthinfo data bases are often available at land grant university libraries and other places that deal with WATSTORE data on a regular basis. For more information, contact Earthinfo (formerly US West Optical Publishing), 5541 Central Avenue, Boulder, Colorado 80301; phone number (303) 938-1788.

Gathering or collecting hydrologic data is covered in a variety of publications (Bovee 1982; Milhous and Bovee 1978; Hamilton and Bergensen 1984).

When referring to streamflow data, a year may be considered as several different time periods—for example, calendar year, water year, climatological year, power year, fish year, and so forth. Be sure that you understand what type of year is being referred to when using the TSLIB programs; WATSTORE data is in water years. Figure 2.1 diagrams the various types of years.

Acquiring Streamflow Data Using the WATSTORE Data Base

The Water Resources Division of the U.S. Geological Survey supports the National Water Data Storage and Retrieval System (WATSTORE). WATSTORE is a computer-based data management system centrally located at the USGS National Center in Reston, Virginia. It is designed to receive, store, and distribute data pertaining to the nation's water resources. Relevant hydrologic data include surface water measurements, ground water measurements, water quality variables, and water use statistics.

Of particular interest to TSLIB users are the daily and peak streamflow measurements for sites throughout the United States. Approximately 16,000 stream gaging stations are currently in operation recording data to be added to the following files:

1. *Daily values file*—a compilation of current and historical data observations made on a daily or continuous basis; includes daily streamflow records.
2. *Peak flows file*—a collection of peak discharges and associated gage-height data in an on-line file.

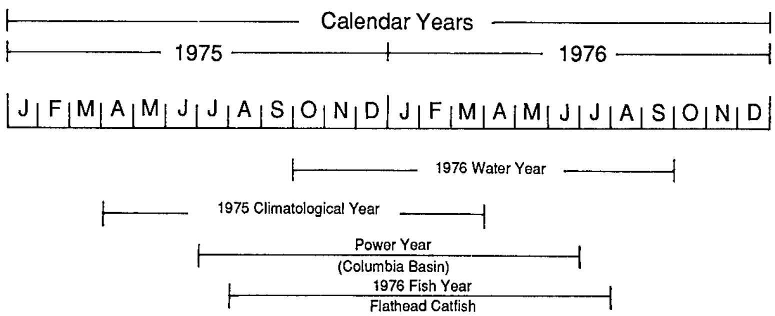


Fig. 2.1. Diagram of yearly time periods.

Programs have been developed to provide users with a method for retrieving information from WATSTORE. These programs interactively prompt the user with a series of questions pertaining to the type of data desired. After the questions are completed, an output file is produced in the form of a WATSTORE request job. This file is transferred to the USGS Amdahl mainframe computer using a microcomputer communications software package and is submitted for execution on the Amdahl. See Appendix G for information on running WATSTORE on the USGS Amdahl computer. Users are responsible for obtaining their own communications software package.

Figure 2.2 is a flowchart of the flow of information through WATSTORE.

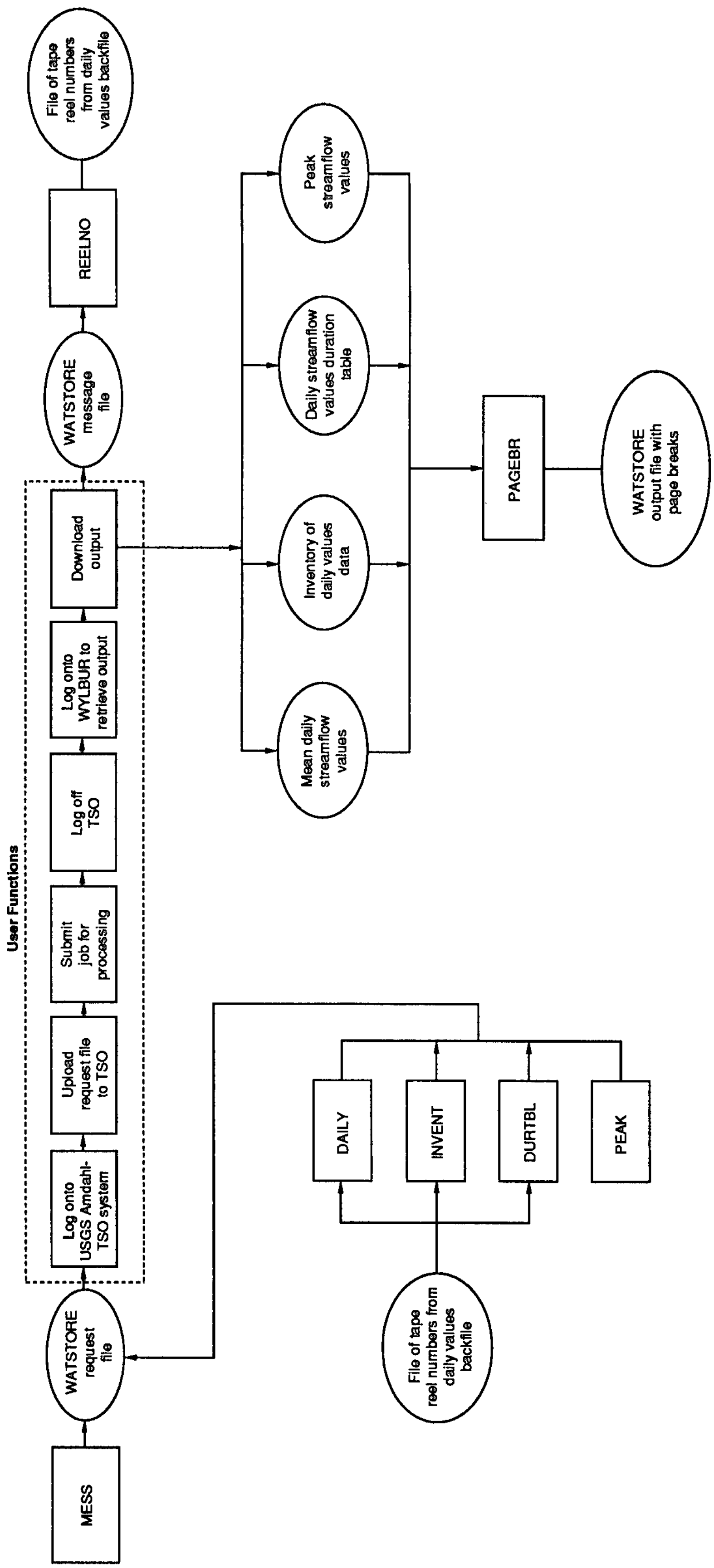


Fig. 2.2. Flow of information through WATSTORE.

Acquiring Streamflow Data Using WATSTORE

Program Name	Batch/Procedure Filename	Function	Program Description
MESS	RMESS	Streamflow data acquisition	Generates a WATSTORE message request file to retrieve data from the WATSTORE data base for use with the GETREL program. **RMESS, WATREQ** **WATREQ** = Request file to obtain WATSTORE message file (output).
GETREL	RGETREL	Streamflow data acquisition	Processes the WATSTORE message file (obtained by submitting the file created by the MESS program) and generates a file of tape reel numbers from the daily values backfile. This file is used by the DAILY, DURTBL, and INVENT programs when generating a request job from WATSTORE. **RGETREL, WATMESS, REELNO** **WATMESS** = WATSTORE message file (input). **REELNO** = File of tape reel numbers from the daily values backfile (output).
DAILY	RDAILY	Streamflow data acquisition	Generates a mean daily streamflow values request file to retrieve data from the WATSTORE data base. **RDAILY, REELNO, WATREQ** **REELNO** = File of tape reel numbers from the daily values backfile (input). This file was created by the GETREL program. **WATREQ** = WATSTORE request file to obtain mean daily streamflow values (output).
DURTBL	RDURTBL	Streamflow data acquisition	Generates a daily streamflow values duration table request file to retrieve data from the WATSTORE data base. The retrieved data can be used as input to the DQDUR program (Chapter 6). **RDURTBL, REELNO, WATREQ** **REELNO** = File of tape reel numbers from the daily values backfile (input). This file was created by the GETREL program. **WATREQ** = WATSTORE request file to obtain daily streamflow values duration table (output).

Program Name	Batch/Procedure Filename	Function	Program Description
INVENT	**RINVENT**	Streamflow data acquisition	Generates a station inventory request file to inventory daily values data from the WATSTORE data base. **RINVENT, REELNO, WATREQ** **REELNO** = File of tape reel numbers from the daily values backfile (input). This file was created by the GETREL program. **WATREQ** = WATSTORE request file to obtain an inventory of daily values data (output).
PEAK	**RPEAK**	Streamflow data acquisition	Generates a peak streamflow values request file to retrieve data from the WATSTORE data base. **RPEAK, WATREQ** **WATREQ** = WATSTORE request file to obtain peak streamflow values (output).

Direct Entry of Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
QIN	**RQIN**	Streamflow data entry	Creates a streamflow data file in WATSTORE or USGS format from keyboard entry or from a free-formatted ASCII file created with an editor. Type INFODQ or INFOMQ for information on the format of the free-formatted input file for daily or monthly streamflow. **RQIN, ZQFIL, ZQIN** **ZQFIL** = Daily streamflow file in WATSTORE format or monthly streamflow file in USGS format (output). **ZQIN** = Free-formatted ASCII text file containing responses to program prompts. If no filename is entered, keyboard input is assumed (input).

Manipulation of Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
CHGFMT	**RCHGFMT**	Monthly time series manipulation	Changes a USGS format file to a NWDC format file (or vice versa). **RCHGFMT, ZMTS, ZMTSN** **ZMTS** = Monthly time series file in USGS or NWDC format; can be multirecord file (input). **ZMTSN** = New monthly time series file in NWDC or USGS format; will be multirecord if ZMTS is (output).
DQFY	**RDQFY**	Streamflow data manipulation	Removes incomplete years from a daily streamflow file in WATSTORE format for use with the CEDUR, DQTOMQ, and HABTD programs. DQFY also removes excess title lines (files from Hydrodata contain extra title lines). **RDQFY, ZDQ, ZDQN** **ZDQ** = Daily streamflow file in WATSTORE format (input). **ZDQN** = New daily streamflow file in WATSTORE format with complete years and 2 title lines (output).
DQTOMQ	**RDQTOMQ**	Streamflow data manipulation	Reads a daily streamflow file in WATSTORE format and writes a monthly streamflow file in NWDC format. **RDQTOMQ, ZDQ, ZMONQ** **ZDQ** = Daily streamflow file in WATSTORE format (input). This file must have been run through DQFY to remove incomplete years and excess title lines. **ZMONQ** = Monthly streamflow file in NWDC format (output).
PAGEBR	**RPAGEBR**	Streamflow data manipulation	Prepares a WATSTORE output file (generated using the request file created by the DAILY, DURTBL, INVENT, or PEAK programs) for printing. PAGEBR inserts a printer control character where printing should begin on a new page. **RPAGEBR, ZIN, ZOUT** **ZIN** = WATSTORE output file (input). **ZOUT** = WATSTORE output file with page breaks (output).

Program Name	Batch/Procedure Filename	Function	Program Description
SELDUR	**RSELDUR**	Streamflow data manipulation	Takes a WATSTORE duration analysis file (created by submitting the request file created by DURTBL to WATSTORE) and creates a smaller file with the same information, which can be used as input to the DQDUR program (Chapter 6). **RSELDUR, WATDUR, ZREDUR** **WATDUR** = WATSTORE duration analysis file (input). **ZREDUR** = Reduced WATSTORE duration analysis file (output).

Listing of Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
CEDUR	**RCEDUR**	Streamflow data listing	Analyzes a daily flow file and produces six different reports, including daily, monthly, and yearly data summaries; flow exceedence percentages by month or by a user-defined period; and percentage exceedence flows for user-defined percentages. **RCEDUR, ZDQ, ZOUT** **ZDQ** = Daily streamflow file in WATSTORE format (input). This file must have been run through the DQFY program to remove incomplete years and extra title lines. **ZOUT** = Data summaries, exceedence percentages, and percentage exceedence flows (output).
LSTDQ	**RLSTDQ**	Streamflow data listing	Writes a file containing header information and title lines or information by water years in a daily streamflow file. WATSTORE files may contain several data sets with individual title lines. **RLSTDQ, ZDQ, ZOUT** **ZDQ** = Daily streamflow file in WATSTORE format (input). **ZOUT** = LSTDQ results (output). If filename is not specified and only headings are requested, output will go to the screen.

Refer to Appendix A for a sample daily streamflow file in WATSTORE format (ZDQ) and a monthly streamflow file in U.S. Geological Survey (USGS) and Northwest Water Data Center (NWDC) format (ZMONQ).

CEDUR Program

Introduction

The CEDUR program analyzes a daily flow file and produces six different reports, including daily, monthly, and yearly data summaries; flow exceedence percentages by month or by a user-defined period; and percentage exceedence flows for user-defined percentages.

Running CEDUR

RCEDUR, ZDQ, ZOUT

ZDQ = Daily streamflow file in WATSTORE format (input); (this file must have been run through the DQFY program to remove incomplete years and extra title lines).

ZOUT = Data summaries, exceedence percentages, and percentage exceedence flows (output).

```
YOU MAY CHOOSE ANY OR ALL OF THESE 6 REPORTS:

 1 MONTHLY FLOW STATISTICS FOR EACH YEAR
 2 DAILY FLOW STATISTICS FOR ALL YEARS COMBINED
 3 MONTHLY FLOW STATISTICS FOR ALL YEARS COMBINED
 4 MEAN MONTHLY FLOW STATISTICS
 5 DAILY FLOW DURATION BY GIVEN TIME PERIOD
 6 DAILY FLOW DURATION BY MONTHS

ENTER:    1 TO SELECT A REPORT, 0 TO TURN DOWN A REPORT.

1 2 3 4 5 6
:
```

Enter the appropriate number (1 or 0) below the report number to indicate what reports you want. See Figs. 2.3–2.7 for sample output for each report.

> If you get one of the error messages, ERROR IN DAILY FLOW FILE—PLEASE CHECK YOUR DATA SET or ERROR—INCOMPLETE YEAR, check to ensure that you ran the daily flow file through the DQFY program to remove incomplete years and extra title lines.

Option 1

Figure 2.3 contains sample output if option 1, Monthly flow statistics for each year, is selected. This option prints out the maximum, minimum, average, and median flow for each month of each year. It also indicates the day of the maximum and minimum flows.

Option 2

Figure 2.4 contains sample output if option 2, Daily flow statistics for all years combined, is selected. This option prints out the maximum, minimum, average, and median flow for each day of the year and indicates the year of the maximum and minimum flows. This option is only useful if more than one year of data is in the daily streamflow file.

Option 3

Figure 2.5 contains sample output if option 3, Monthly flow statistics for all years combined, is selected. This option prints out the maximum, minimum, average, and median flow for each month and indicates the year and the day for the maximum and minimum flows. The maximum, minimum, and average flows for the entire streamflow file are also printed.

```
DATE - 90/03/28.   H 12142000   47365412142440053530335W17110010 64.00        1130.00   PROGRAM - CEDUR
TIME - 09.37.45.   N 12142000   N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.             PAGE -     1

                                ***** MONTHLY FLOW DATA *****

         MONTH  YEAR     MAXIMUM  DAY      MINIMUM  DAY      AVERAGE      MEDIAN    COUNT
          OCT   1970     1370.00    9       116.00    4       363.84      288.00       31
          NOV   1970     3090.00   24       152.00    5       588.87      400.00       30
          DEC   1970     2550.00    6       165.00   25       480.13      282.00       31
          JAN   1970     4050.00   19       158.00    6       937.68      796.00       31
          FEB   1970     2270.00   13       308.00   28       834.11      530.00       28
          MAR   1970     1100.00   30       215.00   21       396.55      310.00       31
          APR   1970      725.00   27       288.00   19       444.27      412.00       30
          MAY   1970     1670.00   12       601.00   18      1053.77     1010.00       31
          JUN   1970     1420.00   22       556.00   29       875.37      808.00       30
          JUL   1970     1110.00   10       476.00   31       717.16      650.00       31
          AUG   1970      428.00    1        89.00   29       176.84      148.00       31
          SEP   1970      677.00    2        80.00   23       208.37      160.00       30
   ALL MONTHS   1970     4050.00  JAN 19     80.00  SEP 23    588.40      450.00      365
```

Fig. 2.3. Sample output when option 1 is chosen in the CEDUR program.

```
DATE - 90/03/28.   H 12142000   4736541214244005353033SW17110010  64.00        1130.00        PROGRAM - CEDUR
TIME - 10.06.57.   N 12142000   N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.                 PAGE -     1
```

***** DAILY FLOW DATA *****

DAY	MONTH	MAXIMUM	YEAR	MINIMUM	YEAR	AVERAGE	MEDIAN	COUNT
1	OCT	468.00	1981	51.00	1974	202.25	138.00	12
2	OCT	1480.00	1981	62.00	1979	268.58	129.00	12
3	OCT	578.00	1981	59.00	1979	180.58	141.00	12
4	OCT	376.00	1981	56.00	1979	158.58	156.00	12
5	OCT	431.00	1970	54.00	1979	174.33	156.00	12
6	OCT	1570.00	1981	53.00	1979	280.17	146.00	12
7	OCT	1530.00	1981	51.00	1979	268.25	145.00	12
8	OCT	1130.00	1981	50.00	1979	223.83	137.00	12
9	OCT	1370.00	1970	50.00	1979	330.33	131.00	12
10	OCT	766.00	1970	49.00	1974	249.08	145.00	12
11	OCT	547.00	1981	48.00	1979	200.58	153.00	12
12	OCT	764.00	1973	47.00	1974	226.67	128.00	12
13	OCT	2440.00	1973	45.00	1974	394.33	145.00	12
14	OCT	1110.00	1973	44.00	1974	253.75	144.00	12
15	OCT	684.00	1975	44.00	1974	230.33	131.00	12
16	OCT	367.00	1975	43.00	1974	179.83	123.00	12
17	OCT	654.00	1975	41.00	1974	189.58	117.00	12
18	OCT	1250.00	1975	40.00	1974	230.75	112.00	12
19	OCT	1110.00	1975	40.00	1974	290.92	138.00	12
20	OCT	790.00	1971	44.00	1974	255.42	147.00	12
21	OCT	507.00	1975	47.00	1974	218.67	143.00	12
22	OCT	499.00	1975	46.00	1974	202.33	124.00	12
23	OCT	710.00	1970	44.00	1974	230.25	148.00	12
24	OCT	740.00	1970	42.00	1974	269.33	247.00	12
25	OCT	802.00	1977	41.00	1974	368.08	406.00	12
26	OCT	2280.00	1971	40.00	1974	502.50	330.00	12
27	OCT	767.00	1979	40.00	1974	333.83	273.00	12
28	OCT	853.00	1979	48.00	1974	337.67	245.00	12
29	OCT	1420.00	1975	53.00	1974	408.58	248.00	12
30	OCT	2450.00	1975	54.00	1974	534.42	209.00	12
31	OCT	1150.00	1975	55.00	1974	441.67	247.00	12

Fig. 2.4. Sample output when option 2 is chosen in the CEDUR program.

```
DATE - 90/03/28.   H 12142000   4736541214244005353033SW17110010  64.00      1130.00        PROGRAM - CEDUR
TIME - 10.06.57.   N 12142000   N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.               PAGE -     1
```

***** FLOW DATA BY MONTH *****

MONTH	MAXIMUM	YEAR	DAY	MINIMUM	YEAR	DAY	AVERAGE	MEDIAN	COUNT
OCT	2450.00	1975	30	40.	1974	18	279.	170.	372
NOV	4350.00	1971	4	60.	1974	5	594.	406.	360
DEC	7400.00	1975	2	132.	1979	1	850.	487.	372
JAN	6650.00	1981	24	125.	1978	9	646.	325.	372
FEB	7280.00	1981	14	0.	1972	29	609.	380.	339
MAR	3540.00	1971	6	156.	1975	8	485.	327.	372
APR	4220.00	1980	28	189.	1972	3	526.	452.	360
MAY	2470.00	1971	22	252.	1979	17	729.	642.	372
JUN	3290.00	1973	5	156.	1976	30	695.	615.	360
JUL	3280.00	1971	13	81.	1972	31	402.	290.	372
AUG	1200.00	1975	20	48.	1976	19	177.	128.	372
SEP	2070.00	1979	2	50.	1972	17	238.	148.	360

Fig. 2.5. Sample output when option 3 is chosen in the CEDUR program.

Option 4

Figure 2.6 contains sample output if option 4, Mean monthly flow statistics, is selected. This option prints out the maximum, minimum, average, and median flows for each month and indicates the year of the maximum and minimum mean monthly flows.

Option 5

Figure 2.7 contains sample output if option 5, Daily flow duration by given time period, is selected. This option prompts the user to enter a period from 5–100 days and to enter up to 17 exceedence percentages to be calculated. The output contains a flow duration table for all of the time periods, a flow duration table for the period entered (the year is divided into 5–100 day segments), and an exceedence flows table for each period.

```
NOTE:  WHEN USING THE OPTION FOR TIME PERIODS, THE LAST
       TIME PERIOD WILL CONTAIN THE REMAINING DAYS OF THE
       YEAR AND MAY NOT CONTAIN THE NUMBER OF DAYS
       REQUESTED FOR EACH TIME PERIOD.
ENTER THE NUMBER OF DAYS IN EACH TIME PERIOD (5-100):
```

For this sample output, 90 days was entered.

```
ENTER THE NUMBER OF EXCEEDENCE PERCENTAGES (1-17)
TO BE CALCULATED:
```

For this sample output, 5 was entered.

```
ENTER THE [IN THIS EXAMPLE] 5 EXCEEDENCE PERCENTAGES:
```

For this sample output, 20 40 60 80 100 were the 5 entries. These are the percent exceedence figures for the flows in the table at the end of the CEDUR output (Fig. 2.6).

Option 6

Option 6, Daily flow duration by months, is similar to option 5 except that the output contains flow duration tables for each month instead of for a variable period. This option prompts the user to enter up to 17 exceedence percentages to be calculated. The output contains a flow duration table for all of the time periods, a flow duration table for each month, and an exceedence flows table for each month.

```
DATE - 90/03/28.   H 12142000   47365412142440053530335W17110010  64.00    1130.00     PROGRAM - CEDUR
TIME - 10.06.57.   N 12142000   N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.            PAGE -    1

                           ***** YEARLY FLOW DATA *****

           MAXIMUM  MONTH DAY YEAR    MINIMUM  MONTH DAY YEAR    AVERAGE    COUNT

           7400.00   DEC   2  1975      0.00    FEB  29  1972     518.59    4383

                       ***** MEAN MONTHLY FLOW DATA *****

           MONTH     MAXIMUM  YEAR    MINIMUM  YEAR    AVERAGE    MEDIAN

           OCT        526.13  1981      50.94  1974     278.56    194.87
           NOV        969.07  1977     134.73  1979     594.19    387.73
           DEC       1556.03  1975     464.52  1978     849.62    518.32
           JAN       1105.45  1973     222.06  1978     645.91    526.13
           FEB       1294.68  1981     211.00  1972     610.61    526.13
           MAR       1250.29  1971     243.87  1975     485.35    500.16
           APR        874.47  1980     279.20  1974     526.46    500.16
           MAY       1169.74  1971     452.23  1979     729.36    526.13
           JUN       1338.43  1973     397.57  1977     694.96    527.60
           JUL        732.74  1971     141.94  1976     401.65    524.03
           AUG        322.84  1975      63.58  1972     177.23    491.03
           SEP        452.27  1977      87.03  1978     237.85    452.75
```

Fig. 2.6. Sample output when option 4 is chosen in the CEDUR program.

DATE - 90/03/30. H 12142000 47365412142440053530333SW17110010 64.00 30.00 PROGRAM - CEDUR
TIME - 09.52.31. N 12142000 N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA. PAGE - 1

FLOW DURATION TABLE FOR ALL TIME PERIODS

FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +
10000.00	0.00	8000.00	0.00	7000.00	0.05	6000.00	0.11	5000.00	0.21	4500.00	0.27
4000.00	0.43	3500.00	0.62	3000.00	0.98	2500.00	1.55	2000.00	2.58	1700.00	3.47
1400.00	5.29	1200.00	7.44	1000.00	11.00	800.00	16.22	700.00	20.72	600.00	26.67
500.00	35.04	450.00	39.52	400.00	44.95	350.00	51.13	300.00	58.77	250.00	67.15
200.00	75.47	170.00	80.54	140.00	85.63	120.00	88.84	100.00	91.81	80.00	94.84
70.00	96.33	60.00	97.90	50.00	99.27	45.00	99.66	40.00	99.93	35.00	99.93
30.00	99.93	25.00	99.93	20.00	99.93	17.00	99.93	14.00	99.93	12.00	99.93
10.00	99.93	8.00	99.93	7.00	99.93	6.00	99.93	5.00	99.93	4.50	99.93
4.00	99.93	3.50	99.93	3.00	99.93	2.80	99.93	2.60	99.93	2.40	99.93
2.20	99.93	2.00	99.93	1.80	99.93						

MAXIMUM FLOW THIS PERIOD: 7400.0
MINIMUM FLOW THIS PERIOD: 0.0
DAYS IN PERIOD: 4383

DATE - 90/03/30. H 12142000 47365412142440053530333SW17110010 64.00 30.00 PROGRAM - CEDUR
TIME - 09.52.31. N 12142000 N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA. PAGE - 1

FLOW DURATION TABLE FOR TIME PERIOD FROM 1 OCT TO 29 DEC

FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +	FLOW	PERCENT = / +
7500.00	0.00	7000.00	0.09	6500.00	0.28	6000.00	0.28	5500.00	0.28	5000.00	0.37
4500.00	0.46	4000.00	0.83	3600.00	1.11	3300.00	1.20	3000.00	1.67	2800.00	2.41
2600.00	2.78	2400.00	3.24	2200.00	3.98	2000.00	5.28	1800.00	6.02	1600.00	6.85
1500.00	7.69	1400.00	8.70	1300.00	9.72	1200.00	11.02	1100.00	12.87	1000.00	14.72
900.00	16.30	800.00	18.61	750.00	20.00	700.00	22.69	650.00	25.46	600.00	27.78
550.00	30.65	500.00	34.91	450.00	38.80	400.00	43.52	360.00	47.22	330.00	51.76
300.00	56.48	280.00	58.98	260.00	61.85	240.00	64.81	220.00	67.69	200.00	71.11
180.00	75.00	160.00	78.70	150.00	80.83	140.00	83.06	130.00	85.00	120.00	87.31
110.00	89.17	100.00	91.02	90.00	93.43	80.00	94.63	75.00	94.91	70.00	95.28
65.00	95.93	60.00	96.39	55.00	96.85	50.00	97.78	45.00	98.89	40.00	100.00

MAXIMUM FLOW THIS PERIOD: 7400.0
MINIMUM FLOW THIS PERIOD: 40.0
DAYS IN PERIOD: 1080

**A table for each period will be printed.
At the end of the output, the following table will be printed.**

******** EXCEEDENCE FLOWS TABLE BY TIME PERIOD ********

PERCENTAGES GIVEN:

TIME PERIOD:	20.00	40.00	60.00	80.00	100.00
OCT 1 - DEC 29	750.	437.	273.	154.	40.
DEC 30 - MAR 29	698.	416.	299.	225.	10.
MAR 30 - JUN 27	874.	642.	493.	369.	180.
JUN 28 - SEP 25	424.	236.	151.	95.	45.
SEP 26 - SEP 30	322.	244.	140.	77.	50.

Fig. 2.7. Sample output when option 5 is chosen in the CEDUR program

CHGFMT Program

Introduction

The CHGFMT program changes a USGS format file to a NWDC format file or vice versa. The files can be any type of monthly time series format that includes monthly streamflow files (ZMONQ).

Running CHGFMT

RCHGFMT, ZMTS, ZMTSN

ZMTS = Monthly time series file in USGS or NWDC format; can be a multirecord file (input).

ZMTSN = New monthly time series file in NWDC or USGS format; will be a multirecord file if ZMTS is (output).

DAILY Program

Introduction

The DAILY program generates a Mean daily streamflow values request file to retrieve data from the WATSTORE data base.

Before running DAILY, you must have obtained the WATSTORE message file and processed the message file using the GETREL program. The MESS program generates a WATSTORE message request file to retrieve the data from the WATSTORE data base.

Running DAILY

RDAILY, REELNO, WATREQ

REELNO = File of tape reel numbers from the daily values backfile (input). This file was created by the GETREL program.

WATREQ = WATSTORE request file to obtain mean daily streamflow values (output).

Your responses to the following questions should all be in UPPER CASE. Set the <Caps Lock> key active.

```
Enter your USER ID (7 alphanumeric characters) →

Enter your ACCOUNT NUMBER (9 digits) →

Enter a 5 letter AGENCY ABBREVIATION and your
3 INITIALS, separated by a comma and IN QUOTES
(for example, 'USFWS,CLL') →
```

Do not forget to enter the quotes and comma!

```
JOB PRIORITY LEVELS determine how fast a job executes:

    A — 30 MINUTES          3X BILLING FACTOR
    B — 2 HOURS             2X BILLING FACTOR
    C — 5 HOURS             1X BILLING FACTOR
    E — 24 HOURS            .6X BILLING FACTOR
    G — 99 HOURS            .3X BILLING FACTOR

What PRIORITY LEVEL will this job have? →
```

The higher the priority level, the more expensive the job is to run.

```
Do you want the DAILY values converted to MONTHLY
values, thus obtaining 12 values per water year
instead of 365? (Y/N) →
```

The output is the same when PUNched output is requested. The DQTOMQ program could be run to convert the daily streamflow file to a monthly streamflow file.

```
Do you want PRInted or PUNched output? (PRI/PUN) →
```

Enter PRI if you are only interested in reviewing the data and not using it as input to other programs.

Enter PUN if you want to use the data as input to other programs. The data will be written in USGS format. When the punched format is requested, some printed information will be written to the top of the output file. After reviewing this information, delete it up to the header line (line starting with H). This file is then a daily streamflow file (ZDQ).

```
Enter an 8 digit STATION NUMBER →

Enter the 2 letter STANDARD ABBREVIATION for the State
for which this station is located.
(For a code listing, enter ZZ) →

Enter additional STATION NUMBERS (maximum of 4)
(all MUST be in the same State as the first station).
Terminate with a 0 (zero) →

Enter dates of interest at the following prompts.
If the entire record is of interest, leave dates blank.

Enter FIRST YEAR and MONTH [yyyymm] →

Enter LAST YEAR and MONTH [yyyymm] →
```

Years are in water years—that is, October is month 1 and September is month 12.

```
The request file you have created is [the name specified
when the program was invoked will be displayed here].
Transfer this file to the AMDAHL computer in Reston, VA using
a microcomputer communications software package.
```

If you receive this message, you have probably successfully created the DAILY request job. Figure 2.8 is a sample Daily request job.

Things to check:

- Are all characters in upper case?
- Are the correct user ID and account number entered on line 1?

```
//USERID# JOB (ACCOUNT#,H475,10,20,3000),'USFWS,MAU',
//        CLASS=E,MSGLEVEL=(2,0)
/*ROUTE   PRINT RMT240
/*ROUTE   PUNCH RMT240
//PROCLIB DD DSN=WRD.PROCLIB,DISP=SHR
/*SETUP      561575/H
//S1 EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSUT2 DD SYSOUT=A,DCB=BLKSIZE=80
//SYSIN DD DUMMY
//SYSUT1 DD *
/*
//S2 EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSUT2 DD SYSOUT=B
//SYSIN DD DUMMY
//SYSUT1 DD *
/*
//S3 EXEC DVRETR,AGENCY=USGS,VOL1=561575
//HDR.SYSIN  DD  *
M3                                                     XX
R00060
F00003
P999999
Q999999
D        02433500
/*
//
```

Fig. 2.8. Sample DAILY request job.

- Are there quotes around your agency and initials and are they separated with a comma (line 1)?
- Did you specify the job priority level (CLASS=) that you desire on line 2?
- Is there a 6-digit number before the last slash on the /*SETUP line?
- Is there an 8-digit station number on the D line(s)?
- Does the second to the last line contain the characters /*?
- Does the last line contain the characters //?

If any items are missing or incorrect, the job will not run. You may correct simple errors such as user ID and account number with an editor. If other errors are identified, it is recommended that DAILY be run again and the file recreated.

The Mean daily streamflow values request file is now ready to be uploaded to the AMDAHL mainframe computer in Reston, Virginia, using a microcomputer communications package. Refer to Appendix G for instructions for logging on to the AMDAHL computer, submitting jobs for processing, and recovering output from the WYLBUR Fetch Queue.

Before printing information obtained from WATSTORE using a request file created by DAILY, the PAGEBR program could be run on the WATSTORE output file to insert a printer control character at points where printing should begin on a new page.

DQFY Program

Introduction

The DQFY program removes incomplete years from a daily streamflow file in WATSTORE format for use with the CEDUR, DQTOMQ, and HABTD programs; DQFY also removes excess title lines. Files from Hydrodata contain extra title lines. Therefore they need to be run through the DQFY program before they can be used as input to the TSLIB programs.

Daily streamflow files from WATSTORE may contain data from at least one gaging station for one to several years; data for one gaging station constitutes one set of data. Before running the CEDUR, DQTOMQ, and HABTD programs, the DQFY program should be run on the daily streamflow file to ensure that only complete years are included and that there are only two title lines in the file (the CEDUR, DQTOMQ, and HABTD programs will only accept two title lines). Title lines begin with H, N, or Y in column 1. (Lines with the string ENT beginning in column 55 indicate the beginning of yearly data and are not title lines).

Running DQFY

RDQFY, ZDQ, ZDQN

ZDQ = Daily streamflow file in WATSTORE format (input).

ZDQN = New daily streamflow file in WATSTORE format with complete years and two title lines (output).

DQTOMQ Program

Introduction

The DQTOMQ program reads a daily streamflow file in WATSTORE format and writes a monthly streamflow file in NWDC format.

Daily streamflow files from WATSTORE may contain data from at least one gaging station for one to several years; data for one gaging station constitutes a set of data. Before running DQTOMQ, the DQFY program should be run on the daily streamflow file to ensure that only complete years are included, and that there are only two title lines in the file (the DQTOMQ program will only accept two title lines). Title lines begin with H, N, or Y in column 1. (Lines with the string ENT beginning in column 55 indicate the beginning of yearly data and are not title lines).

Running DQTOMQ

RDQTOMQ, ZDQ, ZMONQ

ZDQ = Daily streamflow file in WATSTORE format (input). This file must have been run through DQFY to remove incomplete years and excess title lines.

ZMONQ = Monthly streamflow file in NWDC format (output).

DURTBL Program

Introduction

The DURTBL program generates a Daily streamflow values duration table request file to retrieve data from the WATSTORE data base. The retrieved data can be used as input to the DQDUR program (Chapter 6).

Before running DURTBL, you must have obtained the WATSTORE message file and processed the message file through the GETREL program. The MESS program generates a WATSTORE message request file to retrieve the data from the WATSTORE data base.

Running DURTBL

RDURTBL, REELNO, WATREQ

REELNO = File of tape reel numbers from the daily values backfile (input). This file was created by the GETREL program.

WATREQ = WATSTORE request file to obtain daily streamflow values duration table (output).

Your responses to the following questions should all be in UPPER CASE. Set the <Caps Lock> key active.

```
Enter your USER ID (7 alphanumeric characters) →

Enter your ACCOUNT NUMBER (9 digits) →

Enter a 5 letter AGENCY ABBREVIATION and your
3 INITIALS, separated by a comma and IN QUOTES
(for example, 'USFWS,CLL') →
```

Do not forget to enter the quotes and comma!

```
JOB PRIORITY LEVELS determine how fast a job executes:

   A - 30 MINUTES           3X BILLING FACTOR
   B - 2 HOURS              2X BILLING FACTOR
   C - 5 HOURS              1X BILLING FACTOR
   E - 24 HOURS            .6X BILLING FACTOR
   G - 99 HOURS            .3X BILLING FACTOR

What PRIORITY LEVEL will this job have? →
```

The higher the PRIORITY LEVEL, the more expensive the job is to run.

```
Enter an 8 digit STATION NUMBER →

Enter the 2 letter STANDARD ABBREVIATION for the State
for which this station is located.
(For a code listing, enter ZZ) →
Enter additional STATION NUMBERS (maximum of 4)
(all MUST be in the same State as the first station).
Terminate with a 0 (zero) →

Enter dates of interest at the following prompts.
If the entire record is of interest, leave year blank.

Enter FIRST YEAR (yyyy) →
Enter LAST YEAR (yyyy) →
```

Years are in water years—that is, October is month 1 and September is month 12.

```
The request file you have created is [the name specified
when the program was invoked will be displayed here].
Transfer this file to the AMDAHL computer in Reston, VA
using a microcomputer communications software package.
```

If you receive this message, you have probably successfully created the DURTBL request job. Figure 2.9 is a sample DURTBL request job.

Things to check:

- Are all characters in upper case?
- Are the correct user ID and account number entered on line 1?
- Are there quotes around your agency and initials and are they separated with a comma (line 1)?
- Did you specify the job priority level (CLASS=) that you desire on line 2?
- Is there a 6-digit number before the last slash on the /*SETUP line?
- Is there an 8-digit station number on the D line(s)?
- Does the last line contain the characters //?

If any items are missing or incorrect, the job will not run. You may correct simple errors such as user ID and account number with an editor. If other errors are identified, it is recommended that DURTBL be run again and the file recreated.

The Daily streamflow values duration table request file is now ready to be uploaded to the Amdahl mainframe

```
//ABCD123 JOB (123456789,A969,10,20,3000),'USFWS,MAU',
//        CLASS=C,MSGLEVEL=(2,0)
/*ROUTE   PRINT RMT240
/*ROUTE   PUNCH RMT240
//PROCLIB DD DSN=WRD.PROCLIB,DISP=SHR
/*SETUP    561588/H
//S1 EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSUT2 DD SYSOUT=A,DCB=BLKSIZE=80
//SYSIN DD DUMMY
//SYSUT1 DD *
/*
//S2 EXEC DVRETR,AGENCY=USGS,VOL1=561588
//HDR.SYSIN  DD  *
M3
XA969    MAIN0006000003  X   X              X
XA969    MONA               010203040506070809101112
R00060
F00003
P999999
Q999999
D        12142000
/*
//S3 EXEC DVSTAT
//
```

Fig. 2.9. Sample DURTBL request job.

computer in Reston, Virginia, using a microcomputer communications package. Refer to Appendix G for instructions for logging on to the Amdahl computer, submitting jobs for processing, and recovering output from the WYLBUR Fetch Queue.

Before printing information obtained from WATSTORE using a request file created by DURTBL, the PAGEBR program could be run on the WATSTORE output file to insert a printer control character at points where printing should begin on a new page.

GETREL Program

Introduction

The GETREL program processes the WATSTORE message file (obtained by submitting the request file generated by the MESS program) and generates a file of tape reel numbers from the daily values backfile. This file is used by the DAILY, DURTBL, and INVENT programs when generating a request job from WATSTORE.

GETREL reads the WATSTORE message file and extracts the reel numbers, corresponding State codes and station numbers, then writes this information to a file in the format used by the DAILY, DURTBL, and INVENT programs.

Running GETREL

RGETREL, WATMESS, REELNO

WATMESS = WATSTORE message file (input).

REELNO = File of tape reel numbers from the daily values backfile (output).

INVENT Program

Introduction

The INVENT program generates a station inventory request file to Inventory daily values data from the WATSTORE data base.

Retrieval of daily values data for processing by inventory is restricted to one tape when generating the job request file using the INVENT program. This is not a limitation of the WATSTORE programs on the mainframe but of the program that generates the job request file. The daily values retrieval program can accommodate two input tapes during the same job, so the more experienced user could modify the job request files generated by the programs to use two input tapes. To avoid errors with the input tapes, the retrievals are restricted to one State per job. Again, this is a limitation of the programs and not WATSTORE.

There are three station selection methods available. Two methods involve the specification of station ID's—individual stations and a range of stations. The third method is a polygon retrieval where stations are retrieved according to the boundaries of the polygon. The polygon generated by INVENT contains four latitude–longitude vertices that are created by two vertices entered by the user. When using the polygon retrieval, a special agency identification code may be specified, ALLAG, which retrieves data for all stations in a given area regardless of the agencies operating the stations. Any agency may or may not have data in the WATSTORE data base for any given location. Presently, three States (California, Florida, and Texas) have daily values data stored on more than one tape. This forces the station selection method used to be either individual stations or a station range, because using a station ID, in addition to State code, is the only way of determining the proper tape when multiple tapes are involved.

When an inventory of a station is performed, all daily values are processed; therefore, inventory of stations can be expensive. Care should be taken when using the station selection method of polygon because of the number of stations that may be processed. The cost of a single job using this station selection method could easily exceed $15.00, depending on the size and location.

To use INVENT, you need to know the station selection method of the sites you are interested in, the station numbers or latitude–longitude vertices for station identification, and the State in which the stations are located.

Running INVENT

RINVENT, REELNO, WATREQ

REELNO = File of tape reel numbers from the daily values backfile (input). This file was created by the GETREL program.

WATREQ = WATSTORE request file to inventory daily values data (output).

Your responses to the following questions should all be in UPPER CASE. Set the <Caps Lock> key active.

```
Enter your USER ID (7 alphanumeric characters) →

Enter your ACCOUNT NUMBER (9 digits) →

Enter a 5 letter AGENCY ABBREVIATION and your
3 INITIALS, separated by a comma and IN QUOTES
(for example, 'USFWS,CLL') →
```

Do not forget to enter the quotes and comma!

```
JOB PRIORITY LEVELS determine how fast a job executes:

    A - 30 MINUTES                    3X BILLING FACTOR
    B - 2 HOURS                       2X BILLING FACTOR
    C - 5 HOURS                       1X BILLING FACTOR
    E - 24 HOURS                      .6X BILLING FACTOR
    G - 99 HOURS                      .3X BILLING FACTOR

What PRIORITY LEVEL will this job have? →
```

The higher the priority level, the more expensive the job is to run.

```
Choose a Station Selection Method.
1 - Individual Stations (maximum of 10),
2 - Station Range (Station ID thru Station ID),
3 - Regional (Polygon).

Enter choice →
```

See discussion of these methods in the INVENT "Introduction" section.

Users will be prompted for station numbers after the State prompt (immediately following) is answered. All station numbers must be from the same State. Beginning station numbers must be less than the ending station numbers.

```
Enter the 2 letter STANDARD ABBREVIATION for the State
in which this station is located.
(For a code listing, enter ZZ) →

The request file you have created is [the name specified
when the program was invoked will be displayed here].
Transfer this file to the AMDAHL computer in Reston, VA
using a microcomputer communications software package.
```

If you receive this message, you have probably successfully created the INVENT request job. Figure 2.10 is a sample INVENT request job.

```
//ABCD123 JOB (123456789,H475,10,20,3000),'USFWS,CLL',
//        CLASS=C,MSGLEVEL=2,0)
/*ROUTE  PRINT RMT240
/*ROUTE  PUNCH RMT240
//PROCLIB DD DSN=WRD.PROCLIB,DISP=SHR
/*SETUP      115614/H
//S1 EXEC PGM=IEBGENER
//SYSPRINT DD SYOUT=A
//SYSUT2 DD SYSOUT=A,DCB=BLKSIZE=80
//SYSIN  DD DUMMY
//SYSUT1 DD *
/*
//S2 EXEC DVRETR,AGENCY=USGS,VOL1=115614
//HDR.SYSIN  DD *
M3
XH483                                                   ASP
S        06017012        10523000
/*
//S3 EXEC DVLISTA
/*
//
```

Fig. 2.10. Sample INVENT request job.

Things to check:

- Are all characters in upper case?
- Are the correct user ID and account number entered on line 1?
- Are there quotes around your agency and initials and are they separated with a comma (line 1)?
- Did you specify the job priority level (CLASS=) that you desire on line 2?
- Check the 8-digit station number(s) on the line(s) following line XH483 if station selection method 1 or 2 (individual or range) was chosen, or the 13-digit latitude–longitude vertices if station selection 3 (regional) was chosen.
- Is there a 6-digit number before the last slash on the /*SETUP line?
- Does the second to the last line contain the characters /*?
- Does the last line contain the characters //?

If any of these items are missing or incorrect, the job will not run. You may correct simple errors, such as user ID and account number, with an editor. If other errors are identified, it is recommended that INVENT be run again and the file recreated.

The Inventory of stations request file is now ready to be uploaded to the Amdahl mainframe computer in Reston, Virginia, using a microcomputer communications package. Refer to Appendix G for instructions for logging on to the Amdahl computer, submitting jobs for processing, and recovering output from the WYLBUR Fetch Queue.

Before printing out information obtained from WATSTORE using a request file created by INVENT, the PAGEBR program could be run on the WATSTORE output file to insert a printer control character at points where printing should begin on a new page.

Interpreting Information Provided by Inventory

There are only two items that need any explanation, and those items are under the column headings PARM CODE and STAT CODE. The daily values file parameter codes (PARM CODE) uniquely identify each parameter available for a specific site. The statistic codes (STAT CODE) identify each set of daily or instantaneous data available as to frequency of measurement or statistical reduction of the data.

Modifications to the parameter code list are expected to be quite high; therefore, WATSTORE users are recommended to periodically obtain a list by submitting the following job (substituting the appropriate user ID and account number in the first line):

```
//USERID#  JOB (123456789,WMSG),'USFWS,ARM',CLASS=C
/*ROUTE  PRINT RMT240
//PROCLIB DD DSN=WRD.PROCLIB,DISP=SHR
//  EXEC LPARM
//SORTLIB DD DUMMY
/*
//
```

After submitting this job, retrieve it as you would any other WATSTORE data or information.

To retrieve daily values using specific parameters and statistic codes, you must alter the parameter (R) and statistic (F) lines within a daily values request file. First, create a request file using the DAILY program then use an ASCII editor to change the R and F lines as desired. The formats of the lines are given below.

Parameter (R) Line. As many as 15 parameter codes may be specified on the R line, beginning in the left-most field. This line only needs to be coded if the retrieval is to be restricted to a given set of parameter codes. If the R line is not present, daily values data for all parameters will be retrieved. Specifying the parameters to limit the amount of data retrieved to what is actually needed is recommended.

Col. 1	Enter an R
Col. 2–6, 7–11,	Enter 5-digit parameter code(s).
12–16, 17–21,	Obtained by submitting above file.
22–26, 27–31,	
32–36, 37–41,	
42–46, 47–51,	
52–56, 57–61,	
62–66, 67–71,	
72–76	
Col. 77–78	Blank
Col. 79–80	Retrieval identifier (may be left blank)

Statistic (F) Line. As many as 15 statistic codes may be specified on the F line, beginning in the left-most field. This line need be coded only if the retrieval is to be

restricted to a given set of statistic codes. If the F line is not present, statistic codes will not be considered in selecting daily values records for retrieval.

Col. 1	Enter an F
Col. 2–6, 7–11, 12–16, 17–21, 22–26, 27–31, 32–36, 37–41, 42–46, 47–51, 52–56, 57–61, 62–66, 67–71, 72–76	Enter 5-digit statistic code(s). See statistic code list.
Col. 77–78	Blank
Col. 79–80	Retrieval identifier (may be left blank)

Statistic Code List

Code	Statistic
00001	Maximum[1]
00002	Minimum[1]
00003	Mean
00004	AM (sample taken between 0000–1200 hours)
00005	PM (sample taken between 1200–2400 hours)
00006	Sum
00007	Mode
00008	Median
00009	Standard deviation
00010	Variance
00011	Random instantaneous
00012	Equivalent mean[2]
00013	Skewness
00014–00020	Reserved for future use
00021	Tidal high (Daily)
00022	Tidal low–high (Daily)
00023	Tidal high–low (Daily)
00024	Tidal low (Daily)
00025–00999	Reserved for future use

---

[1] When used in combination with parameter 72019 (distance below LSD), the maximum value for this parameter will be the minimum elevation, and the minimum value for this parameter will be the maximum elevation.

[2] Commonly used with gage-height (parameter code 00065) values that represent an equivalent mean that corresponds to the calculated mean discharges (parameter code 00060).

LSTDQ Program

Introduction

The LSTDQ program writes a file containing header information and title lines *or* information by water years in a daily streamflow file. WATSTORE files may contain several data sets (data from different gaging stations) with individual title lines.

When information is listed by water years, the first two lines of the file and one water year of data are listed on each page, as opposed to all the years being run together and separated by the string ENT in column 55.

If the input file has other than two lines above the first ENT string, these lines will be listed on the first page of the output. If this information is not desired in the LSTDQ output, remove the excess lines with an editor before running LSTDQ.

Running LSTDQ

RLSTDQ, ZDQ, ZOUT

ZDQ = Daily streamflow file in WATSTORE format (input).

ZOUT = LSTDQ results (output). If filename is not specified and only headings are requested, output will go to the screen.

```
ENTER     0 TO LIST HEADERS ONLY
          1 TO LIST INFORMATION BY YEARS
```

Figure 2.11 contains sample output from the LSTDQ program.

Option 0 (List Headers Only):

```
            DATE - 88/11/28.          TIME - 16.12.00.          PROGRAM - LSTDQ

   SET  1
 12142000      4736541214244005353033SW17110010  64.00        1130.00
 12142000      N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
 12142000                0006000003                  ENT
 12142000      19700101 225.00 209.00 200.00 183.00 168.00 166.00 164.00 156.00

  N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.

       STATION ID. -  12142000
       DRAINAGE AREA -    64.00
       PERCENT CONTRIBUTING - 100.00
       LATITUDE - 47 36 54
       LONGITUDE - 121 42 44
       STATE - 53
       COUNTY - 33
       SITE - SW
       HYDROLOGIC UNIT - 17110010
       DATUM -     1130.00
```

Option 1 (List Information by Years):

```
PROGRAM - LSTDQ           DATE - 88/11/28           TIME - 15.57.49.           PAGE -   2

          H 12142000      4736541214244005353033SW17110010  64.00        1130.00
          N 12142000      N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.

            12142000                0006000003                  ENT
          3 12142000      19701001 138.00 129.00 120.00 116.00 431.00 324.00 230.00 205.00
          3 12142000      197010021370.00 766.00 456.00 496.00 362.00 288.00 248.00 218.00
          3 12142000      19701003 198.00 205.00 312.00 362.00 468.00 468.00 710.00 740.00
          3 12142000      19701004 444.00 330.00 273.00 245.00 222.00 209.00 196.00
          3 12142000      19701101 187.00 183.00 172.00 158.00 152.00 183.00 172.00 270.00
          3 12142000      19701102 448.00 297.00 365.001260.00 700.00 424.00 386.001020.00
          3 12142000      19701103 620.00 715.00 720.00 665.00 456.00 348.001310.003090.00
          3 12142000      197011041140.00 665.00 508.00 400.00 340.00 312.00
          3 12142000      19701201 282.00 260.00 240.00 225.00 592.002550.002330.00 975.00
          3 12142000      19701202 606.00 588.00 700.00 476.00 393.00 348.00 351.00 350.00
          3 12142000      19701203 310.00 266.00 250.00 230.00 210.00 200.00 190.00 177.00
          3 12142000      19701204 165.00 165.00 165.00 180.00 260.00 400.00 450.00
          3 12142000      19710101 260.00 220.00 196.00 178.00 169.00 158.00 172.00 500.00
          3 12142000      197101021270.00 960.00 600.00 382.00 315.00 273.00 394.00 814.00
          3 12142000      197101031030.001070.004050.001380.00 796.00 675.001310.001380.00
          3 12142000      197101041020.002380.001550.00 916.00 680.001580.002390.00
          3 12142000      197102011380.00 947.00 705.00 588.00 480.00 412.00 372.00 340.00
          3 12142000      19710202 358.001970.001740.001310.002270.001770.001930.001080.00
          3 12142000      19710203 740.00 640.00 530.00 460.00 440.00 420.00 405.00 580.00
          3 12142000      19710204 460.00 380.00 340.00 308.00
          3 12142000      19710301 282.00 280.00 270.00 250.00 235.00 220.00 320.00 300.00
          3 12142000      19710302 270.00 380.00 560.00 500.00 410.00 355.00 310.00 285.00
          3 12142000      19710303 265.00 240.00 234.00 227.00 215.00 225.00 450.00 760.00
          3 12142000      19710304 500.00 450.00 410.00 380.00 920.001100.00 690.00
          3 12142000      19710401 500.00 436.00 379.00 368.00 448.00 620.00 565.00 529.00
          3 12142000      19710402 610.00 601.00 480.00 400.00 372.00 412.00 448.00 382.00
          3 12142000      19710403 330.00 306.00 288.00 324.00 327.00 300.00 300.00 309.00
          3 12142000      19710404 306.00 534.00 725.00 645.00 560.00 524.00
```

Fig. 2.11. Sample output from the LSTDQ program.

MESS Program

Introduction

The MESS program generates a "WATSTORE message" request file to retrieve data from the WATSTORE data base for use with the GETREL program.

All but the most recent daily values data in the WATSTORE data base are stored on reels of magnetic tape at the Reston computer center. These tape reels are identified and accessed by a six-digit tape reel number assigned more or less according to State. The tape reel numbers are periodically updated when additional daily values are archived onto tape.

To maintain a file of current and correct reel numbers, users of DAILY, DURTBL, and INVENT should periodically (about every 6 months) submit the file created by the MESS program on the Amdahl to obtain the WATSTORE message file.

Running MESS

RMESS, WATREQ

WATREQ = Request file to obtain WATSTORE message file (output).

> Your responses to the following questions should all be in UPPER CASE. Set the <Caps Lock> key active.

```
ENTER YOUR 7-CHARACTER USER ID:
ENTER YOUR 9-DIGIT ACCOUNT NUMBER:
```

Figure 2.12 is a sample WATSTORE message file request job.

Things to check:

- Are all characters in upper case?
- Are the correct user ID and account number entered on line 1?
- Does the second to the last line contain the characters /*?
- Does the last line contain the characters //?

```
//1234567   JOB (999999999,WMSG),'MESSAGE ',CLASS=C
//*
//* THIS JOB PRINTS LISTINGS OF BACKFILE TAPES
//*
/*ROUTE     PRINT RMT240
//PROCLIB  DD  DSN=WRD.PROCLIB,DISP=SHR
//MSG     EXEC MESSAGE,WRDMSG='WRD02'
/*
//
```

Fig. 2.12. Sample WATSTORE message file request job.

If any items are missing or incorrect, the job will not run. You may correct simple errors such as user ID and account number with an editor. If other errors are identified, it is recommended that MESS be run again and the file recreated.

The "WATSTORE message" request file is now ready to be uploaded to the Amdahl mainframe computer in Reston, Virginia, using a microcomputer communications package. Refer to Appendix G for instructions for logging on to the Amdahl computer, submitting jobs for processing, and recovering output from the WYLBUR Fetch Queue.

For the more advanced user, the cost of downloading the entire message file can be reduced by downloading the specific section of importance. An example of the section is given here so that you may identify it. If you are not familiar enough with using the WYLBUR system to locate and display this portion of the message, it is recommended that the entire file be downloaded to avoid confusion.

WATSTORE DAILY VALUES BACKFILE (6250 BPI) TAPE–
FEBRUARY 22, 1990

TAPE NO	BEGINNING STATE CODE	ENDING STATE CODE	STATE ABBREV
561560	01	02	AL, AK
561561	04	05	AZ, AR
561562	06	06(11147070)	CA
561563	06(11147500)	06(11381990)	CA
561564	06(11382000)	06	CA

> Sample terminated here for brevity.

```
******************************************
DAILY VALUE BACKFILE TAPE USERS ARE RE-
MINDED THAT TAPES MUST BE USED BY THE
ORDER OF STATE CODES AND NOT NUMERICALLY.
******************************************
```

> Note: If there are colons at the beginning of each line, remove them (replace colons with blanks) so that the GETREL program will run correctly. Another way to remove the colons would be to see if your communications software has a STRIP CHARACTERS function. If it does, set this function in the communications parameters and resubmit the message request file.

PAGEBR Program

Introduction

The PAGEBR program prepares a WATSTORE output file (generated using the request file created by DAILY, DURTBL, INVENT, or the PEAK program) for printing. PAGEBR inserts a printer control character at points where printing should begin on a new page. The page breaks are determined by key phrases in specific positions—these are known as headers. In the absence of a header, a control character is inserted every 60 lines.

Depending on the type of information requested from WATSTORE, there is limited editing necessary on the output file generated before the data is used, either as input for a program such as PAGEBR or printed for reference or publication. Any ASCII editor may be used. The WATSTORE processing information precedes the data. In most cases, you will want to remove this portion of the output. The importance of this information is to verify the parameters and controls used in the retrieval, and messages such as invalid station numbers and dates. At the end of the retrieved file, there may be lines that should be removed. The lines to remove include the line containing COMMAND? through the end of the file.

Running PAGEBR

RPAGEBR, ZIN, ZOUT

ZIN = WATSTORE output file (input).

ZOUT = WATSTORE output file with page breaks (output).

PEAK Program

Introduction

The PEAK program generates a Peak streamflow values request file to retrieve data from the WATSTORE data base.

Running PEAK

RPEAK, WATREQ

WATREQ = WATSTORE request file to obtain peak streamflow values (output).

> Your responses to the following questions should all be in UPPER CASE. Set the <Caps Lock> key active.

```
Enter your USER ID (7 alphanumeric characters) →

Enter your ACCOUNT NUMBER (9 digits) →

Enter a 5 letter AGENCY ABBREVIATION and your
3 INITIALS, separated by a comma and IN QUOTES
(for example, 'USFWS,CLL') →
```

Do not forget to enter the quotes and comma!

```
JOB PRIORITY LEVELS determine how fast a job executes:

   A - 30 MINUTES               3X BILLING FACTOR
   B - 2 HOURS                  2X BILLING FACTOR
   C - 5 HOURS                  1X BILLING FACTOR
   E - 24 HOURS                .6X BILLING FACTOR
   G - 99 HOURS                .3X BILLING FACTOR

What PRIORITY LEVEL will this job have? →
```

The higher the priority level, the more expensive the job is to run.

```
Do you want an ANNUAL FLOOD FREQUENCY ANALYSIS
following WRC Guidelines Bulletin 17-B
performed on this data? (Y/N)

Enter dates of interest at the following prompts.
If the entire record is of interest, leave year blank.

Enter FIRST YEAR and MONTH [yyyymm] →
Enter LAST YEAR and MONTH [yyyymm] →
```

Years are in water years; that is, October is month 1 and September is month 12.

```
Enter an 8-digit STATION NUMBER →

Enter additional STATION NUMBERS (Maximum of 10)
Terminate by entering a 0 (zero) →

The request file you have created is [the name specified when
the program was invoked will be displayed here]. Transfer
this file to the AMDAHL computer in Reston, VA using a micro-
computer communications software package.
```

If you receive this message, you have probably successfully created the PEAK request job. Figure 2.13 is a sample PEAK request job.

Things to check:

- Are all characters in UPPER CASE?
- Are the correct user ID and account number entered on line 1?
- Are there quotes around your agency and initials and are they separated with a comma (line 1)?
- Did you specify the job priority level (CLASS=) that you desire on line 2?
- Is there an 8-digit station number on the I line(s).
- Does the second to the last line contain the characters /*?
- Does the last line contain the characters //?

If any of the above items are missing or incorrect, the job will not run. You may correct simple errors such as user ID and account number with an editor. If other errors are identified, it is recommended that PEAK be run again and the file recreated.

The Peak streamflow values request file is now ready to be uploaded to the Amdahl mainframe computer in Reston, Virginia, using a microcomputer communications package. Refer to Appendix G for instructions for logging on to the Amdahl computer, submitting jobs for processing, and recovering output from the WYLBUR Fetch Queue.

Before printing information obtained from WATSTORE using a request file created by PEAK, the PAGEBR program could be run on the WATSTORE output file to insert a printer control character at points where printing should begin on a new page.

```
//ABCD123 JOB (123456789,H475,10,20,3000),'USFWS,CLL',
//        CLASS=C,MSGLEVEL=2,0)
/*ROUTE  PRINT RMT240
/*ROUTE  PUNCH RMT240
//PROCLIB DD DSN=WRD.PROCLIB,DISP=SHR
//S1 EXEC PGM=IEBGENER
//SYSPRINT DD SYOUT=A
//SYSUT2 DD SYSOUT=A,DCB=BLKSIZE=80
//SYSIN  DD DUMMY
//SYSUT1 DD *
/*
//S2  EXEC  PEAKRET,AGENCY=USGS
//HDR.SYSIN  DD *
M 197010 198009
XJ407    $JOB
I        06710000K
//  EXEC  PKWRCA
/*
//
```

Fig. 2.13. Sample PEAK request job.

QIN Program

Introduction

The QIN program creates a daily streamflow file in WATSTORE format or a monthly streamflow file in USGS format. Information can be entered interactively from the keyboard or be read from a free-formatted ASCII file created with an editor. It is recommended that the data be entered into a free-formatted ASCII file instead of entering it interactively from the keyboard, as the entry of a year of daily flow values is tedious and error prone and no editing is allowed during data entry.

If the data is entered into a free-formatted ASCII file, it must contain the responses to each of the prompts when the data is entered interactively from the keyboard. Each response should be separated by a space or a carriage return. Type INFODQ or INFOMQ for information on the format of the free-formatted input file for daily or monthly streamflows. Figure 2.14 contains a sample daily flow free-formatted ASCII text file used as input to QIN.

Running QIN

RQIN, ZQFIL, ZQIN

ZQFIL = Daily streamflow file in WATSTORE format *or* monthly streamflow data in USGS format (output).

ZQIN = Free-formatted ASCII text file containing responses to program prompts. If no filename is entered, keyboard input is assumed (input).

```
ENTER FORMAT OF FILE BEING CREATED:
  1 FOR WATSTORE FORMAT (DAILY STREAMFLOW FILE),
  2 FOR USGS FORMAT (MONTHLY STREAMFLOW FILE).

ENTER:  0 TO ENTER DATA BY KEYBOARD,
        1 TO USE DATA FROM FREE-FORMATTED FILE.
```

If data is being read from a free-formatted file, the filename must have been entered when RQIN was run, and the file must contain responses for each of the following prompts. Type INFODQ or INFOMQ for information on the format of the free-formatted daily or monthly input streamflow files. Years of data may be separated by a carriage return, if desired, for easier file readability.

```
012142000
47
36
54
121
42
44
53
33
SW
17110010
64
100
1130
N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
1
1929
10
40 39 39 115 260 136 105 86
124 120 94 84 79 73 68 67
236 177 253 198 150 121 104 91
82 83 164 158 124 110 99
91 106 92 84 87 138 111 100
116 149 131 117 109 101 98 130
389 223 155 130 115 105 97 91
144 162 148 134 121 115
108 98 91 85 104 161 144 163
285 469 380 248 415 2490 1080 820
571 410 395 371 321 555 1170 680
885 627 634 457 380 677 576
1120 740 654 571 473 365 288 250
213 196 130 130 130 130 130 130
130 130 130 110 110 110 110 110
110 110 110 110 119 117 259
2640 1200 700 1720 2290 940 1360 1170
660 897 885 571 457 555 1100 1400
1200 1330 1730 1260 802 605 489 395
333 285 250 225
217 206 194 185 187 178 178 189
194 185 202 253 208 185 169 158
156 156 176 187 862 845 457 1520
1590 1030 820 930 908 640 554
505 457 426 457 505 505 1110 1120
622 457 410 457 505 571 660 473
395 380 410 505 700 720 554 522
473 489 554 522 395 318
327 505 489 359 296 336 296 255
236 234 272 315 441 489 426 489
380 327 386 1030 980 1030 740 660
554 441 441 489 457 457 538
660 840 605 489 473 565 588 489
457 457 457 473 426 327 362 362
257 234 267 288 296 250 223 213
204 223 377 489 327 267
248 221 187 171 172 166 150 143
137 136 126 121 117 113 106 100
98 93 90 87 86 83 80 77
74 70 66 64 62 61 59
58 56 55 54 53 53 52 51
49 49 47 47 45 44 44 44
45 44 43 41 41 41 40 39
39 38 37 37 36 36 37
37 36 35 34 34 40 41 42
56 51 48 51 76 276 142 96
83 74 68 64 60 57 55 52
```

Fig. 2.14. Sample free-formatted ASCII file used as input to QIN.

If "1" is entered to create daily streamflow data in WATSTORE format:

> Note: The prompts Enter gaging station ID through Datum contain data used in the WATSTORE system data files. The TSLIB programs do not use these data, except for LSTDQ, which merely displays the values. If you do not care to use the values in the first line of the data set, or do not know the proper values, you may substitute dummy values. After the output file has been created, you may edit the first line of the data set to be another title line, with the title information starting in column 17. The daily streamflow file would then have two title lines.

```
ENTER GAGING STATION ID (15 MAX CHARS)
```

Enter the gaging station ID where the observations for the data set were made. Each line of the daily streamflow file will have the identifier entered on it. The program prints out 15 dashes so you will not exceed the 15-character limit. You may include leading blanks, if you wish.

```
LOCATION
DEGREES LATITUDE:
MINUTES LATITUDE:
SECONDS LATITUDE:

DEGREES LONGITUDE:
MINUTES LONGITUDE:
SECONDS LONGITUDE:
```

There is a certain amount of range checking here so that most absurd numbers cannot be entered by mistake.

```
STATE CODE: (NUMBER BETWEEN 00 AND 99)
```

Enter the State code for the State in which the data was measured. State (and county) codes are found in Federal Information Processing Standards Publication (FIPS PUB) 6-3, 1979. FIPS PUB 6-3 is entitled *Counties and County Equivalents of the States of the United States and the District of Columbia.* This publication implements American National Standard X3.31-1973 (ANSI X3.31-1973). Copies of this publication are for sale by the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161. When ordering, refer to Federal Information Processing Standards Publication 6-3 (NBS-FIPS-PUB-6-3). If you want to enter a dummy value, enter 00.

```
COUNTY CODE: (NUMBER BETWEEN 0 AND 999)
```

Enter the county code, as listed in NBS-FIPS-PUB-6-3. For example, King County, Washington, has the code 033. You may enter just the 33, the program will fill in the leading zero. If you want to enter a dummy value, enter 000. The county code will appear on the first line of the data set.

```
SITE: (2 CHARS MAX)
```

Enter the site code. If you have no site code, enter a dummy value of 2 alphanumeric characters.

```
HYDROLOGIC UNIT: (NUMBER BETWEEN 0 AND 99999999)
```

Enter the hydrologic unit identifier. This must be an integer number from 0 to 99999999. Any integer in this range will suffice for a dummy value.

```
DRAINAGE AREA: (NUMBER BETWEEN 1 AND 9999999)
```

Enter the drainage area of this hydrologic unit. The value should be from 1 to 9999999. It may contain decimal values, if the area is ≤ 9999.99.

```
CONTRIBUTING DRAINAGE AREA: (NUMBER BETWEEN 0 AND 9999999)
```

Enter the area of the hydrologic unit above the gaging station (that area directly contributing to the discharge at this site). The value may be from 0 to 9999999.

```
DATUM: (NUMBER BETWEEN 0 AND 99999999)
```

Enter the datum value as specified by the WATSTORE documentation. The data we will be entering are discharge (cfs), daily mean. The DATUM value can be 0 to 99999999. A good dummy value is 0.

```
ENTER A TITLE NAME FOR THIS DATA SET: (MAX 48 CHARS)
```

Enter a descriptive name for the data or the site from which the data were taken.

> Note: From this point on, no dummy values should be entered.

```
ENTER 0 FOR BREAKS IN YEARS, 1 FOR NO BREAKS:
```

If the years of data are all sequential, enter 1. If there is 1 year (or more) of data missing from the data to be entered, enter 0. For example, if the data are for 1983, 1984, 1985, 1986, 1987, and 1988 you would enter 1. If at least 1985's data were missing, you would enter 0.

```
ENTER YEAR:
```

If you entered "1" above, this prompt appears for the first year. Enter the first year for which you will enter data. If there are breaks in years, you will see this prompt for each year of data you enter.

```
ENTER STARTING MONTH (1-12):
```

You do not have to enter data beginning with January. You may wish to enter the data for a water year (beginning in October). The program will change years when the data for the next January is encountered in the input data.

```
ENTER DAILY DATA FOR A YEAR
(365 DAYS):
```

Enter the daily mean discharge in cubic feet per second for the number of values prompted for, separated by one or more spaces, a carriage return, or a comma. To repeat a value, enter repeat factor*value. For example, 3*55 = entering 55 three times.

The program expects 365 values, except for leap years when 366 values are to be entered. (In the year 2000, 367 values will need to be entered, as this is a double leap year, with 30 days in February.)

```
ENTER 0 TO STOP OR 1 TO ADD DATA FOR MORE YEARS.
```

> Note: If you are entering the data into a free-formatted file, do not enter a value for this prompt.

If you choose to enter more data you will be prompted as follows, depending on whether there are breaks in years of data or if the data is in sequential years.

If "0" was entered to indicate that there were breaks in years, the program will return to the prompt Enter year and continue from there.

If "1" was entered to indicate that there were no breaks in years, then you will be prompted to enter the data for the next year.

If "2" was entered to create monthly streamflow data in USGS format:

```
ENTER TITLE OF DATA (2 LINES)
```

The first two lines in the monthly streamflow data file may contain up to 80 characters per line to record information such as the name of the river, section of the river involved, and any other information describing the data.

```
ENTER STATION IDENTIFICATION (8 CHARS MAX):
```

Enter a gaging station ID to be written to the output file, 8 characters or less.

```
ENTER 0 FOR BREAKS IN YEARS, 1 FOR NO BREAKS.
```

If the years of data are all sequential, enter 1. If there is 1 year (or more) of data missing from the data to be entered, enter 0.

If "0" is entered for "break in years":

```
ENTER YEAR
```

Enter year for data being entered.

If "1" is entered for "no breaks":

```
ENTER FIRST YEAR
```

Enter the first year for which you have data. The program will continue the sequence of years.

```
ENTER MONTHLY DATA
```

Enter the 12 data values for the year. These values may be entered one per line (a number followed by pressing either the return or enter key) or may be entered several per line, separated by a comma and (or) one or more spaces.

```
ENTER 0 TO STOP OR 1 TO ADD DATA FOR MORE YEARS.
```

> Note: If you are entering data into a free-formatted file, do not enter a value for this prompt.

If you choose to enter more data, you will be prompted as follows depending on whether there are breaks in years of data or if the data is in sequential years.

If "0" was entered to indicate that there were breaks in years, the program will return to the prompt enter year and continue from there.

If "1" was entered to indicate that there were no breaks in years, then you will be prompted to enter the data for the next year.

SELDUR Program

Introduction

The SELDUR program takes a WATSTORE duration analysis file (created by submitting the request file created by DURTBL to WATSTORE) and creates a smaller file with the same information that can be used as input to the DQDUR program.

The DQDUR program will accept the large WATSTORE duration analysis file as input or the reduced file created by SELDUR. If the large WATSTORE file is used as input, DQDUR will automatically run SELDUR and create the reduced file as output.

Running SELDUR

RSELDUR, WATDUR, ZREDUR

WATDUR = WATSTORE duration analysis file (input).

ZREDUR = Reduced WATSTORE duration analysis file (output).

The reduction process takes a while to complete. A message will appear when the reduction is completed.

Chapter 3.
Entry, Manipulation, Listing, and Display of the Habitat Area-versus-Streamflow Function

Introduction

Users of TSLIB are responsible for obtaining a credible physical habitat area-versus-streamflow function for each life stage and species to be analyzed. This function may be output from the habitat simulation programs contained in the Physical Habitat Simulation System (PHABSIM) or can be entered directly by the user using the CRHAQF program.

The end result of PHABSIM is a habitat area-versus-streamflow function (ZHAQF file) for any number of species and life stages. Programs in PHABSIM can be used to merge various ZHAQF files with the goal of developing a habitat area-versus-streamflow function applicable to a reach of river.

Please note that the use of PHABSIM is not the only way of developing a credible habitat area-versus-streamflow function; any other system or logic may be used. In all cases, a credible habitat area-versus-streamflow function is required.

The programs presented in Chapter 3 are intended to help the user display the habitat area-versus-streamflow function in various ways and to manipulate the function with a goal of better understanding the nature of the system being analyzed. (Note: The SUMHQF, HBOUTA, and LPTHQF programs included in Chapter 3 are also in PHABSIM.)

After the desired habitat area-versus-streamflow function is obtained, analysts often need to look at the data or present the data in a form that can be useful for report writing. The HABOUT and HBOUTA programs are available to write data in various ways without doing much analysis in the process. The LPTHQF program can be used to plot the habitat area-versus-streamflow function using character or screen graphics.

The habitat area-versus-streamflow function may be for individual cross sections or other subsets of the segment for which a single function for each life stage is desired. The COMHQF program is available to combine ZHAQF files from more than one site to better represent a stream segment.

Sometimes it is desirable to change the way the various life stages and species are organized in a file (or files). For example, if the analyst is just interested in reviewing data for one life stage of one or more species, the MRGHQF program could be used to merge several files to create a single file containing the desired information.

In reviewing the habitat area-versus-streamflow function, the relative value of the habitat for different life stages or species can sometimes cause confusion. In this instance, the NRMHQF program can be used to express the habitat as percent of the peak habitat for the life stage.

For many studies it is useful to transfer a known habitat area-versus-streamflow function within a watershed. The NRMHQF program can be used to normalize the function to facilitate the transfer.

In those situations where the mean monthly flow or some other monthly statistic is known, it is desirable to work with this data without all the other programs in TSLIB. The HAQINT and HABOUT programs allow the user to select this option. For example, if the mean monthly flow is known, it may be useful to determine and display the habitat associated with this mean monthly flow.

Direct Entry of the Habitat Area-versus-Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
CRHAQF	**RCRHAQF**	ZHAQF file entry	Creates a habitat area-versus-streamflow file in the same format as created by the habitat simulation programs in PHABSIM. The program prompts for flows and weighted usable areas (WUA). An unlimited number of species, each with 1–5 life stages, can be included. **RCRHAQF, ZHAQF** **ZHAQF** = Habitat-versus-flow file (output).

Manipulation of the Habitat Area-versus-Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
COMHQF	**RCOMHQF**	ZHAQF file manipulation	Sums or combines habitat area data from two habitat area-versus-streamflow files. Weighting factors are supplied by the user when files are combined. The weight for the first file must be less than or equal to "1." The weight for the second file is assumed to be "1" minus the first file weight. Any number of ZHAQF files may be combined by adjusting the weight factors and running COMHQF on two ZHAQF files at a time. **RCOMHQF, ZHAQFN, ZHAQF, ZHAQF2, ZOUT** **ZHAQFN** = Summed or combined habitat-versus-flow file (output). **ZHAQF** = Habitat-versus-flow file (input). **ZHAQF2** = Habitat-versus-flow file (input). **ZOUT** = Summed or combined habitat area in tables for each life stage (output).
HAQINT	**RHAQINT**	ZHAQF file manipulation	Uses a given habitat area-versus-streamflow file to estimate habitat for different flows by interpolation. **RHAQINT, ZHAQFN, ZHAQF** **ZHAQFN** = Habitat-versus-flow file for requested flows (output). **ZHAQF** = Habitat-versus-flow file (input).

Program Name	Batch/Procedure Filename	Function	Program Description
MRGHQF	**RMRGHQF**	ZHAQF file manipulation	Extracts up to five life stages from one or two habitat area-versus-streamflow files and creates a new habitat area-versus-streamflow file. **RMRGHQF, ZHAQFN, ZHAQF, ZHAQF2** **ZHAQFN** = Habitat-versus-flow file with selected life stages (output). **ZHAQF** = Habitat-versus-flow file (input). **ZHAQF2** = Habitat-versus-flow file (input).
MULHQF	**RMULHQF**	ZHAQF file manipulation	Weights individual life stages, or multiplies or divides habitat values in a habitat area-versus-streamflow file by a constant. **RMULHQF, ZHAQFN, ZHAQF** **ZHAQFN** = Habitat-versus-flow file with adjusted habitat values (output). **ZHAQF** = Habitat-versus-flow file (input).
NRMHQF	**RNRMHQF**	ZHAQF file manipulation	Normalizes habitat values in a habitat area-versus-streamflow file with respect to a given discharge and the corresponding area. If the given discharge is not on the file, it will be added and the habitat values will be calculated by interpolation for the discharge. If the first record in the input file is not area, the user will be prompted to enter the area. **RNRMHQF, ZHAQFN, ZHAQF** **ZHAQFN** = Normalized habitat-versus-flow file (output). **ZHAQF** = Habitat-versus-flow file (input).
SUMHQF	**RSUMHQF**	ZHAQF file manipulation	Sums conditional cover columns in a ZHAQF file into one habitat-versus-flow figure for each life stage. Run when conditional cover curves were used as input to the habitat simulation programs. Allows up to five life stages to be grouped in each record. **RSUMHQF, ZHAQF, ZHAQFN** **ZHAQF** = Habitat-versus-flow file (input). **ZHAQFN** = Modified ZHAQF file with columns summed (output).

Listing of the Habitat Area-versus-Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
HABOUT	**RHABOUT**	ZHAQF file listing	Arranges a habitat area-versus-streamflow file by month and determines the total area per 1,000 feet of stream water for each flow, with an option to compute a yearly average for each flow. HABOUT also computes the adult equivalent habitat for each species. **RHABOUT, ZHAQFM, ZOUT, ZHAQFN** **ZHAQFM** = Habitat-versus-flow file for 12 months (input). Same format as ZHAQF file except only 12 values are entered, 1 per month. If more than 12 values are in the input file, only the first 12 are read. **ZOUT** = HABOUT results (output). **ZHAQFN** = Habitat-versus-flow file with adult equivalent habitat values (output).
HBOUTA	**RHBOUTA**	ZHAQF file listing	Writes the data from a habitat area-versus-streamflow file into a format that may be useful for report purposes. **RHBOUTA, ZHAQF, ZOUT** **ZHAQF** = Habitat-versus-flow file (input). **ZOUT** = HBOUTA results (output).

Display of the Habitat Area-versus-Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
LPTHQF	**RLPTHQF**	ZHAQF file display	Plots the habitat-versus-flow functions: one species per page; 1–5 life stages. **RLPTHQF, ZHAQF, ZOUT** **ZHAQF** = Habitat-versus-flow file (input). **ZOUT** = LPTHQF results (output).

COMHQF Program

Introduction

The COMHQF program sums or combines habitat area data from two habitat-versus-streamflow files. Figure 3.1 is an example of how the COMHQF program is used.

The sum option in COMHQF could be used when a cross section has an island in it. In this case, both sides of the island would be simulated separately, which would result in two ZHAQF files for the cross section. These two ZHAQF files could be combined, which would result in one habitat area-versus-streamflow file for the cross section.

The combine option in COMHQF could also be used when the analyst developed a habitat area-versus-streamflow function for each individual cross section (or a subset of the total). In most situations it is better to create a single habitat area-versus-streamflow function for a segment. The COMHQF program could be used to combine the individual cross-sectional (or reach) data based on weighting factors supplied by the user. The weight for the first file must be less than or equal to "1." The weight for the second file is assumed to be "1" minus the first file weight. Any number of ZHAQF files may be combined by adjusting the weight factors and running COMHQF with each set of two files.

Running COMHQF

RCOMHQF, ZHAQFN, ZHAQF, ZHAQF2, ZOUT

ZHAQFN = Summed or combined habitat-versus-flow file (output).

ZHAQF = Habitat-versus-flow file (input).

ZHAQF2 = Habitat-versus-flow file (input).

ZOUT = Summed or combined habitat area in tables for each individual life stage (output).

The two title lines from the two input files are displayed.

```
ENTER TWO LINE TITLE
```

These two title lines will be in the summed or combined output file.

If the life stage lines are not the same on both ZHAQF files specified as input, the following message will appear (but the program will not terminate):

"Warning—Life stage titles do not match. Will use life stage title from first HAQF file"

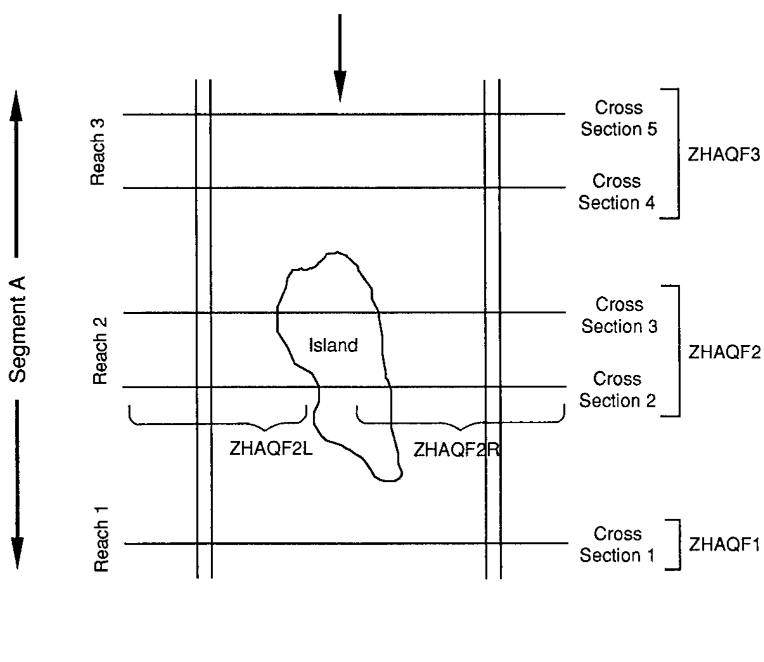


Fig. 3.1. Using COMHQF first to combine habitat area-versus-streamflow functions for reach 2, then for the segment as a whole.

Input files need to be in the same format and contain the same type of information to be logically combined—that is, combining different habitat simulation figures for different discharges, species, and life stages of fish would be illogical.

```
ENTER  0 TO SUM HAQF FILES,
       1 TO COMBINE WITH WEIGHTS:
```

If "0" is entered to sum HAQF files, the following logic is used:

$$Q_2 = Q_{2L} + Q_{2R}$$

$$HA_2 = HA_{2L} + HA_{2R}$$

For example, the first step in the process of combining the ZHAQF files in Fig. 3.1 would be to sum the two parts for reach 2 (ZHAQF2)—in this example, the habitat areas *and* streamflow sum.

If "1" is entered to combine with weights:

```
ENTER WEIGHT FOR WUA ON SET 1 -
```

The weight for the first file must be ≤1. The weight for the second file is assumed to be 1 minus the first file weight.

The next step in the process of combining ZHAQF files in Fig. 3.1 would be to combine the three individual ZHAQF files with weights to result in a habitat-versus-flow function for the segment:

$$Q = Q_1 = Q_2 = Q_3$$

$$HAS = W_1HA_1 + W_2HA_2 = W_3HA_3$$

The equation used when combining two files with weights is

$$HAS = (HA1 \times W1) + (HA2 \times W2)$$

$$W2 = 1.0 - W1$$

$$W1 \leq 1.0$$

$$Q1 = Q2$$

where

HA1 = habitat area from the first HAQF file,

HA2 = habitat area from the second HAQF file, (this file could be the result of combining two previous files),

HAS = combined habitat area,

W1 = weight on first HAQF file,

W2 = weight on second HAQF file,

Q1 = streamflow from first HAQF file, and

Q2 = streamflow from second HAQF file.

For example, suppose there are three cross sections with individual cross-sectional weights of W_1, W_2, and W_3 that sum to 1.0. The equation for the segment as a whole (HAS) is

$$HAS = W_1HA_1 + W_2HA_2 = W_3HA_3,$$

which can be arranged to

$$HAS = \left[\frac{W_1HA_1}{W_1 + W_2} + \frac{W_2HA_2}{W_1 + W_2}\right] W_1 + W_2 + W_3HA_3.$$

Therefore, for the first time through COMHQF, use weights HA1 and HA2 where

$$HA1 = HA_1 \quad W1 = \frac{W_1}{W_1 + W_2}$$

$$HA2 = HA_2 \quad W2 = \frac{W_2}{W_1 + W_2}$$

and the end product is HA_{12}.

```
First ZHAQF file used as input to COMHQF:

SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
          DISCHARGE       FRY         JUVENILE      ADULT
              10.00    20570.00        8220.00     5780.00
             100.00    15400.00        4770.00     3200.00
             150.00    18880.00        7230.00     4890.00
             200.00    19790.00        9360.00     6410.00
             250.00    19780.00       11470.00     8020.00
             300.00    19110.00       13140.00     9410.00
             350.00    18050.00       14110.00    10400.00
             400.00    16290.00       15850.00    12600.00
             500.00    14470.00       16360.00    13660.00
             600.00    11030.00       14610.00    13380.00
             800.00     9090.00       12310.00    11740.00
            1000.00     7410.00        9270.00     8880.00
            1500.00     6940.00        8490.00     7620.00
            2000.00     7210.00        8630.00     7810.00
            4000.00     6660.00        9480.00     8510.00
            6000.00     5740.00        9890.00     9670.00
***************

Second ZHAQF file used as input to COMHQF:

SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WA.
SAMPLE ZHAQF FILE TO USE WITH THE COMHQF PROGRAM.
RAINBOW TROUT
          DISCHARGE       FRY         JUVENILE      ADULT
              10.00     2050.00         822.00      578.00
             100.00     1540.00         477.00      320.00
             150.00     1888.00         723.00      489.00
             200.00     1979.00         936.00      641.00
             250.00     1978.00        1147.00      802.00
             300.00     1911.00        1314.00      941.00
             350.00     1805.00        1411.00     1040.00
             400.00     1629.00        1585.00     1260.00
             500.00     1447.00        1636.00     1366.00
             600.00     1103.00        1461.00     1338.00
             800.00      909.00        1231.00     1174.00
            1000.00      741.00         927.00      888.00
            1500.00      694.00         849.00      762.00
            2000.00      721.00         863.00      781.00
            4000.00      666.00         948.00      851.00
            6000.00      574.00         989.00      967.00
***************
```

Fig. 3.2. Sample input files to COMHQF.

For the second and last times through COMHQF, use weights HA1 and HA2, now defined as

$$HA1 = HA_{12} \quad W1 = W_1 + W_2$$

$$HA2 = HA_3 \quad W2 = W_3$$

and the end product is HAS.

Figure 3.2 contains two sample input files for the COMHQF program. Figure 3.3 is sample output using the sum option. Figure 3.4 is sample output using the combine option.

```
NEW ZHAQF FILE FOR SNOQUALMIE RIVER WHICH RESULTED BY SUMMING
THE TWO ZHAQF FILES IN FIGURE 3.2 USING THE SUM OPTION IN COMHQF
RAINBOW TROUT
        DISCHARGE      FRY         JUVENILE       ADULT
* 1         20.00    22620.00      9042.00      6358.00
* 2        200.00    16940.00      5247.00      3520.00
* 3        300.00    20768.00      7953.00      5379.00
* 4        400.00    21769.00     10296.00      7051.00
* 5        500.00    21758.00     12617.00      8822.00
* 6        600.00    21021.00     14454.00     10351.00
* 7        700.00    19855.00     15521.00     11440.00
* 8        800.00    17919.00     17435.00     13860.00
* 9       1000.00    15917.00     17996.00     15026.00
*10       1200.00    12133.00     16071.00     14718.00
*11       1600.00     9999.00     13541.00     12914.00
*12       2000.00     8151.00     10197.00      9768.00
*13       3000.00     7634.00      9339.00      8382.00
*14       4000.00     7931.00      9493.00      8591.00
*15       8000.00     7326.00     10428.00      9361.00
*16      12000.00     6314.00     10879.00     10637.00
***************
```

Fig. 3.3. Sample output using the sum option in COMHQF.

```
NEW ZHAQF FILE FOR SNOQUALMIE RIVER WHICH RESULTED BY COMBINING
THE TWO ZHAQF FILES IN FIGURE 3.2 WITH A WEIGHT OF .40 FOR THE FIRST FILE
RAINBOW TROUT
        DISCHARGE      FRY         JUVENILE      ADULT
* 1         10.00     9458.00      3781.20     2658.80
* 2        100.00     7084.00      2194.20     1472.00
* 3        150.00     8684.80      3325.80     2249.40
* 4        200.00     9103.40      4305.60     2948.60
* 5        250.00     9098.80      5276.20     3689.20
* 6        300.00     8790.60      6044.40     4328.60
* 7        350.00     8303.00      6490.60     4784.00
* 8        400.00     7493.40      7291.00     5796.00
* 9        500.00     6656.20      7525.60     6283.60
*10        600.00     5073.80      6720.60     6154.80
*11        800.00     4181.40      5662.60     5400.40
*12       1000.00     3408.60      4264.20     4084.80
*13       1500.00     3192.40      3905.40     3505.20
*14       2000.00     3316.60      3969.80     3592.60
*15       4000.00     3063.60      4360.80     3914.60
*16       6000.00     2640.40      4549.40     4448.20
***************
```

Fig. 3.4. Sample output using the combine option in COMHQF. A weight of 0.40 was used for the first file.

CRHAQF Program

Introduction

The CRHAQF program creates a habitat area-versus-streamflow (ZHAQF) file in the same format as created by the habitat simulation programs in PHABSIM. An unlimited number of species, each with 1–5 life stages, can be entered.

The CRHAQF program is useful when the habitat area-versus-streamflow function was developed using techniques or programs not in PHABSIM.

Running CRHAQF

RCRHAQF, ZHAQF

ZHAQF = Habitat area-versus-streamflow file (output).

```
ENTER TITLE (2 LINES)
```

These 2 lines may contain up to 80 characters per line to record information such as the name of the river, section of the river involved, and any other information describing the data.

```
HOW MANY FLOWS (30 MAX):

ENTER THE [--] FLOWS:
```

Enter each flow in ascending order, followed by a space, comma, or carriage return.

```
ENTER SPECIES NAME (40 CHAR MAX):
```

The first record in the ZHAQF files created by the PHABSIM programs contains total area information; the TSLIB programs do not require this information. If it is being entered, enter "Total area" here in place of the species name.

```
HOW MANY LIFE STAGES (5 MAX):
```

Enter the number of life stages for this species. The weighted usable areas (WUA) will be entered for each life stage and for each flow.

> If Total area information is being entered as the first record, enter 1 at this prompt and enter "Area" as the life stage name in the next prompt.

```
ENTER LIFE STAGE NAME FOR SET [-] (10 CHARS MAX)
```

This prompt appears for the number of life stages specified for the species.

```
ENTER THE [--] WUA'S FOR LIFE STAGE: [--]
```

Enter a weighted usable area (WUA) for each of the flows specified.

```
ENTER 0 TO STOP, OR 1 TO ENTER ANOTHER SPECIES.
```

Figure 3.5 is a sample ZHAQF file.

```
SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
      DISCHARGE       FRY          JUVENILE      ADULT
          10.00     20570.00       8220.00      5780.00
         100.00     15400.00       4770.00      3200.00
         150.00     18880.00       7230.00      4890.00
         200.00     19790.00       9360.00      6410.00
         250.00     19780.00      11470.00      8020.00
         300.00     19110.00      13140.00      9410.00
         350.00     18050.00      14110.00     10400.00
         400.00     16290.00      15850.00     12600.00
         500.00     14470.00      16360.00     13660.00
         600.00     11030.00      14610.00     13380.00
         800.00      9090.00      12310.00     11740.00
        1000.00      7410.00       9270.00      8880.00
        1500.00      6940.00       8490.00      7620.00
        2000.00      7210.00       8630.00      7810.00
        4000.00      6660.00       9480.00      8510.00
        6000.00      5740.00       9890.00      9670.00
***************
```

Fig. 3.5. Sample habitat area-versus-streamflow (ZHAQF) file.

HABOUT Program

Introduction

The HABOUT program arranges a habitat area-versus-streamflow file by month and determines the total available area per 1,000 feet of stream water for each flow, with an option to compute a yearly average for each flow. HABOUT also computes the adult equivalent habitat for each species.

The HABOUT program is a carryover from the early days of habitat analysis using PHABSIM. The first implementation of a time series analysis was to develop a habitat area-versus-streamflow function with 12 values of discharge—1 for each month. A common case was when the 12 values were the average discharge for each month. The program is still useful when the median discharge is an adequate representation for time series analysis.

Running HABOUT

RHABOUT, ZHAQFM, ZOUT, ZHAQFN

ZHAQFM = Habitat-versus-flow file for 12 months (input). Same format as ZHAQF file except only 12 values are entered, 1 per month. If more than 12 values are in the input file, only the first 12 are read.

ZOUT = HABOUT results (output).

ZHAQFN = Habitat-versus-flow file with adult equivalent habitat values (output).

```
ENTER:  0 TO PRINT OUT EQUIVALENT AREA ONLY,
        1 TO PRINT OUT HABITAT AREA FOR ALL LIFE STAGES
          FOR REQUESTED MONTHS, OR
        2 TO PRINT OUT HABITAT AREA FOR REQUESTED LIFE
          STAGES AND MONTHS, LEAVING OTHERS BLANK.
```

If "0" is entered, only the table of month versus discharge and the equivalent area will be written to the output file.

If "1" is entered, the user specifies the months to be written to the table of month versus discharge and the equivalent area that is written to the output file. A "Q versus available habitat area per 1,000 feet of stream for (species name)" is also written for the months specified.

If "2" is entered, the user specifies the first and last valid month for each life stage and a weight for the adult equivalent area for each life stage.

The following prompts will be asked if options 1 or 2 are selected.

The months on the data set are displayed along with their ID number:

```
ID   MONTH
1    JANUARY
2    FEBRUARY
3    MARCH
  ..........
12     DECEMBER

ENTER ID FOR FIRST MONTH OF DATA SET:
```

This will label the first entry on the input data set with the corresponding month name. For example, if the first entry on the input data set is January, enter 1. If the first entry on the data set is October, enter 10.

```
ENTER 1 TO CONVERT FROM ENGLISH TO METRIC, 2 FOR NO
CONVERSION:
```

Enter 1 if you want the output printed in metric units instead of English (meters instead of feet).

```
ENTER 1 FOR WUA PRINTED XX.XX, 2 FOR WUA PRINTED XX:
```

Weighted usable area (WUA) and flow (Q) can be printed in the output with or without a decimal point.

```
ENTER 1 FOR Q PRINTED XX.XX, 2 FOR Q PRINTED XX:

ENTER 1 FOR A BINDING EDGE, 2 FOR NO BINDING EDGE.
```

The binding edge is on the top of the paper.

If "1" is entered for a binding edge:

```
ENTER NUMBER OF LINES FOR BINDING EDGE:
```

If option 2 was selected, the following promp's will also appear.

Species name will be displayed here.

```
ENTER FIRST AND LAST VALID MONTH FOR life stage:
```

Enter the numbers for the months in calendar years (i.e., June through October would be 6 through 10) relevant for the life stage separated by a space, comma, or carriage return.

```
ENTER WEIGHT FOR ADULT EQUIVALENT AREA life stage:
```

Enter the weight for the life stage, so that the habitat can be adjusted to represent the adult habitat needed if all habitat was utilized.

```
ENTER 1 FOR ANNUAL AVERAGE WUA, 2 FOR NO AVERAGE WUA:
```

If "1" is selected, the annual average will be calculated and printed in the output.

```
ENTER 1 TO PRINT UNITS BELOW TABLE, 2 FOR NO PRINT OF UNITS:
```

If "1" is entered, the following will be printed below each table, depending on whether English or metric units are used:

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1,000 FEET

Q IN CUBIC METERS PER SECOND, WUA IN SQUARE METERS PER 1,000 METERS

Figure 3.6 contains a sample habitat area-versus-streamflow file (in months) that was used as input to the HABOUT program; Fig. 3.7 is sample output from the HABOUT program—option 2 was selected in Fig. 3.7.

The adult equivalent would be written to the ZHAQFN file.

```
HABITAT AREA VS. STREAMFLOW FILE USED TO CREATE
SAMPLE OUTPUT FOR HABOUT PROGRAM
RAINBOW TROUT
       DISCHARGE      FRY       JUVENILE        ADULT
* 1       396.00   16414.64     15723.83     12439.00
* 2       612.00   10689.15     14415.09     13331.56
* 3       739.00    9241.37     12973.33     12436.62
* 4       662.00    9737.56     13750.97     13064.51
* 5       480.00   14874.45     16565.80     13710.09
* 6       470.00   15031.40     16626.67     13716.62
* 7       576.00   11845.63     15043.45     13460.64
* 8       761.00    9193.95     12752.77     12206.36
* 9       686.00    9492.07     13492.07     12897.74
*10       324.00   18687.79     13577.89      9799.84
*11       145.00   18617.17      6979.73      4715.70
*12       218.00   19838.54     10117.76      6973.32
**********
```

Fig. 3.6. Sample ZHAQFM file used as input to the HABOUT program.

Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

MONTH	Q	FRY	JUVENILE	ADULT	ADULT EQUIVALENT
JANUARY	662.00		13750.97	13064.51	13064.51
FEBRUARY	480.00		16565.80	13710.09	13710.09
MARCH	470.00		16626.67	13716.62	13716.62
APRIL	576.00		15043.45	13460.64	13460.64
MAY	761.00		12752.77	12206.36	12206.36
JUNE	686.00	9492.07	13492.07	12897.74	12897.74
JULY	324.00	18687.79	13577.89	9799.84	9799.84
AUGUST	145.00	18617.17	6979.73	4715.70	4715.70
SEPTEMBER	218.00	19838.54	10117.76	6973.32	6973.32
OCTOBER	396.00	16414.64	15723.83	12439.00	12439.00
NOVEMBER	612.00		14415.09	13331.56	13331.56
DECEMBER	739.00		12973.33	12436.62	12436.62
WEIGHT FACTOR		5.00	1.50	1.00	
ANNUAL AVERAGE	505.75	16635.46	13481.11	11545.37	

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET

Fig. 3.7. Sample output from the HABOUT program.

HBOUTA Program

Introduction

The HBOUTA program writes the data from a habitat area-versus-streamflow (ZHAQF) file into a format that may be useful for report purposes.

Running HBOUTA

RHBOUTA, ZHAQF, ZOUT

ZHAQF = Habitat-versus-flow file (input).

ZOUT = HBOUTA results (output).

ZHAQF file used as input to HBOUTA:

```
SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
      DISCHARGE    FRY         JUVENILE     ADULT
          10.00    20570.00     8220.00     5780.00
         100.00    15400.00     4770.00     3200.00
         150.00    18880.00     7230.00     4890.00
         200.00    19790.00     9360.00     6410.00
         250.00    19780.00    11470.00     8020.00
         300.00    19110.00    13140.00     9410.00
         350.00    18050.00    14110.00    10400.00
         400.00    16290.00    15850.00    12600.00
         500.00    14470.00    16360.00    13660.00
         600.00    11030.00    14610.00    13380.00
         800.00     9090.00    12310.00    11740.00
        1000.00     7410.00     9270.00     8880.00
        1500.00     6940.00     8490.00     7620.00
        2000.00     7210.00     8630.00     7810.00
        4000.00     6660.00     9480.00     8510.00
        6000.00     5740.00     9890.00     9670.00
***************
```

```
ENTER 1 TO CONVERT FROM ENGLISH TO METRIC,2 FOR NO CONVERSION.
```

Enter 1 if you want the output printed in metric units instead of English (meters instead of feet).

```
ENTER 1 FOR WUA PRINTED XX.XX, 2 FOR WUA PRINTED XX.
```

Weighted usable area (WUA) and flow (Q) can be printed in the output with or without a decimal point.

```
ENTER 1 FOR Q PRINTED XX.XX, 2 FOR Q PRINTED XX.
ENTER 1 FOR A BINDING EDGE, 2 FOR NO BINDING EDGE.
```

The binding edge is on the top of the paper.
If 1 is entered for a binding edge,

```
HOW MANY LINES FOR BINDING EDGE
```

```
ENTER 1 TO PRINT UNITS BELOW TABLE, 2 FOR NO PRINT OF UNITS.
```

If 1 is entered, the following will be printed below each table, depending on whether English or metric units are used:

Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1,000

Q IN CUBIC METERS PER SECOND, WUA IN SQUARE METERS PER 1,000 METERS

Figure 3.8 contains sample output from the HBOUTA program.

Output from HBOUTA:

```
 90/05/02.                         SNOQUALMIE RIVER                        PROGRAM - HBOUTA
11.15.36.                      NEAR SNOQUALMIE FALLS, WA                     PAGE - 2

        Q VS. AVAILABLE HABITAT AREA PER 1000 FEET OF STREAM FOR RAINBOW TROUT

                          Q          FRY        JUVENILE     ADULT

              1         10.00     20570.00     8220.00     5780.00
              2        100.00     15400.00     4770.00     3200.00
              3        150.00     18880.00     7230.00     4890.00
              4        200.00     19790.00     9360.00     6410.00
              5        250.00     19780.00    11470.00     8020.00
              6        300.00     19110.00    13140.00     9410.00
              7        350.00     18050.00    14110.00    10400.00
              8        400.00     16290.00    15850.00    12600.00
              9        500.00     14470.00    16360.00    13660.00
             10        600.00     11030.00    14610.00    13380.00
             11        800.00      9090.00    12310.00    11740.00
             12       1000.00      7410.00     9270.00     8880.00
             13       1500.00      6940.00     8490.00     7620.00
             14       2000.00      7210.00     8630.00     7810.00
             15       4000.00      6660.00     9480.00     8510.00
             16       6000.00      5740.00     9890.00     9670.00

          Q IN CUBIC FEET PER SECOND, WUA IN SQUARE FEET PER 1000 FEET
```

Fig. 3. 8. Sample output from the HBOUTA program.

HAQINT Program

Introduction

The HAQINT program uses a given habitat area-versus-streamflow (ZHAQF) file to estimate habitat for different flows by interpolation. This program is most useful when only a few discharge values are to be converted to habitat values, and it is especially useful in conjunction with HABOUT.

Running HAQINT

RHAQINT, ZHAQFN, ZHAQF

ZHAQFN = Habitat-versus-flow file for requested flows (output).

ZHAQF = Habitat-versus-flow file (input).

The two title lines from the ZHAQF file are displayed.

```
ENTER 1 FOR NEW TITLE,0 TO USE TITLE FROM ZHAQF FILE:
```

If 1 is entered,

```
ENTER NEW TITLE (2 LINES):

ENTER NUMBER OF FLOWS TO BE ESTIMATED (12 MAX):

ENTER THE [--] FLOWS:

ENTER 0 FOR CUBIC SPLINE INTERPOLATION, OR
      1 FOR LINEAR INTERPOLATION BETWEEN NEAREST FLOWS:
```

If 0 is entered for cubic spline interpolation, flows must be within the range of flows that are on the original ZHAQF file.

If 1 is entered for linear interpolation between nearest flows, and the requested flows are out of range of flows that are on the original ZHAQF file, the two nearest flows are used in interpolation—therefore, the values interpolated may not be accurate. If the points are too far apart, consider redoing the PHABSIM analysis using more points to define the habitat area-versus-streamflow function.

Figure 3.9 contains sample output from the HAQINT program.

```
ZHAQF file used as input to HAQINT:

SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
        DISCHARGE        FRY          JUVENILE        ADULT
            10.00     20570.00        8220.00       5780.00
           100.00     15400.00        4770.00       3200.00
           150.00     18880.00        7230.00       4890.00
           200.00     19790.00        9360.00       6410.00
           250.00     19780.00       11470.00       8020.00
           300.00     19110.00       13140.00      10400.00
           350.00     18050.00       14110.00      12600.00
           400.00     16290.00       15850.00      12600.00
           500.00     14470.00       16360.00      13660.00
           600.00     11030.00       14610.00      13380.00
           800.00      9090.00       12310.00      11740.00
          1000.00      7410.00        9270.00       8880.00
          1500.00      6940.00        8490.00       7620.00
          2000.00      7210.00        8630.00       7810.00
          4000.00      6660.00        9480.00       8510.00
          6000.00      5740.00        9890.00       9670.00
***************

Output ZHAQF file from HAQINT:

HABITAT AREA VS. STREAMFLOW FILE USED TO CREATE
SAMPLE OUTPUT FOR HABOUT PROGRAM
RAINBOW TROUT
       DISCHARGE         FRY          JUVENILE        ADULT
* 1        396.00     16414.64       15723.83      12439.00
* 2        612.00     10689.15       14415.09      13331.56
* 3        739.00      9241.37       12973.33      12436.62
* 4        662.00      9737.56       13750.97      13064.51
* 5        480.00     14874.45       16565.80      13710.09
* 6        470.00     15031.40       16626.67      13716.62
* 7        576.00     11845.63       15043.45      13460.64
* 8        761.00      9193.95       12752.77      12206.36
* 9        686.00      9492.07       13492.07      12897.74
*10        324.00     18687.79       13577.89       9799.84
*11        145.00     18617.17        6979.73       4715.70
*12        218.00     19838.54       10117.76       6973.32
**********
```

Fig. 3.9. Sample output from the HAQINT program. Cubic spline interpolation was used.

LPTHQF Program

Introduction

The LPTHQF program plots the habitat area-versus-streamflow functions—1 species per page; 1–5 life stages.

Running LPTHQF

RLPTHQF, ZHAQF, ZOUT

ZHAQF = Habitat-versus-flow file (input).

ZOUT = LPTHQF results (output).

Figure 3.10 contains sample output from the LPTHQF program. A character graph and a screen graph are both included in this output. For all programs that generate graphs on the microcomputer, the user has the option to display the graphs on the screen or write them to the output file using character graphics (132 characters-per-line format). To use screen graphics, the computer must have a Color Graphics Adaptor (CGA) or compatible graphics card. When using screen graphics, notes are written to the output file in the positions where the graphs would have been placed had they been written using character graphics.

```
DATE - 90/05/01.   SNOQUALMIE RIVER                                  PROGRAM - LPTHQF
TIME - 11.01.23.   NEAR SNOQUALMIE FALLS, WA                            PAGE -    1

PLOTTING EACH LIFE STAGE OF --

RAINBOW TROUT
    A        FRY
    B        JUVENILE
    C        ADULT
    D
    E

                 Q          A          B          C          D          E

      * 1     10.00   20570.00    8220.00    5780.00
      * 2    100.00   15400.00    4770.00    3200.00
      * 3    150.00   18880.00    7230.00    4890.00
      * 4    200.00   19790.00    9360.00    6410.00
      * 5    250.00   19780.00   11470.00    8020.00
      * 6    300.00   19110.00   13140.00    9410.00
      * 7    350.00   18050.00   14110.00   10400.00
      * 8    400.00   16290.00   15850.00   12600.00
      * 9    500.00   14470.00   16360.00   13660.00
      *10    600.00   11030.00   14610.00   13380.00
      *11    800.00    9090.00   12310.00   11740.00
      *12   1000.00    7410.00    9270.00    8880.00
      *13   1500.00    6940.00    8490.00    7620.00
      *14   2000.00    7210.00    8630.00    7810.00
      *15   4000.00    6660.00    9480.00    8510.00
      *16   6000.00    5740.00    9890.00    9670.00
```

Fig. 3.10. Sample output from the LPTHQF program.

```
DATE - 90/05/01.       SNOQUALMIE RIVER                                                          PROGRAM - LPTHQF
TIME - 11.01.23.       NEAR SNOQUALMIE FALLS, WA                                                     PAGE - 1
```

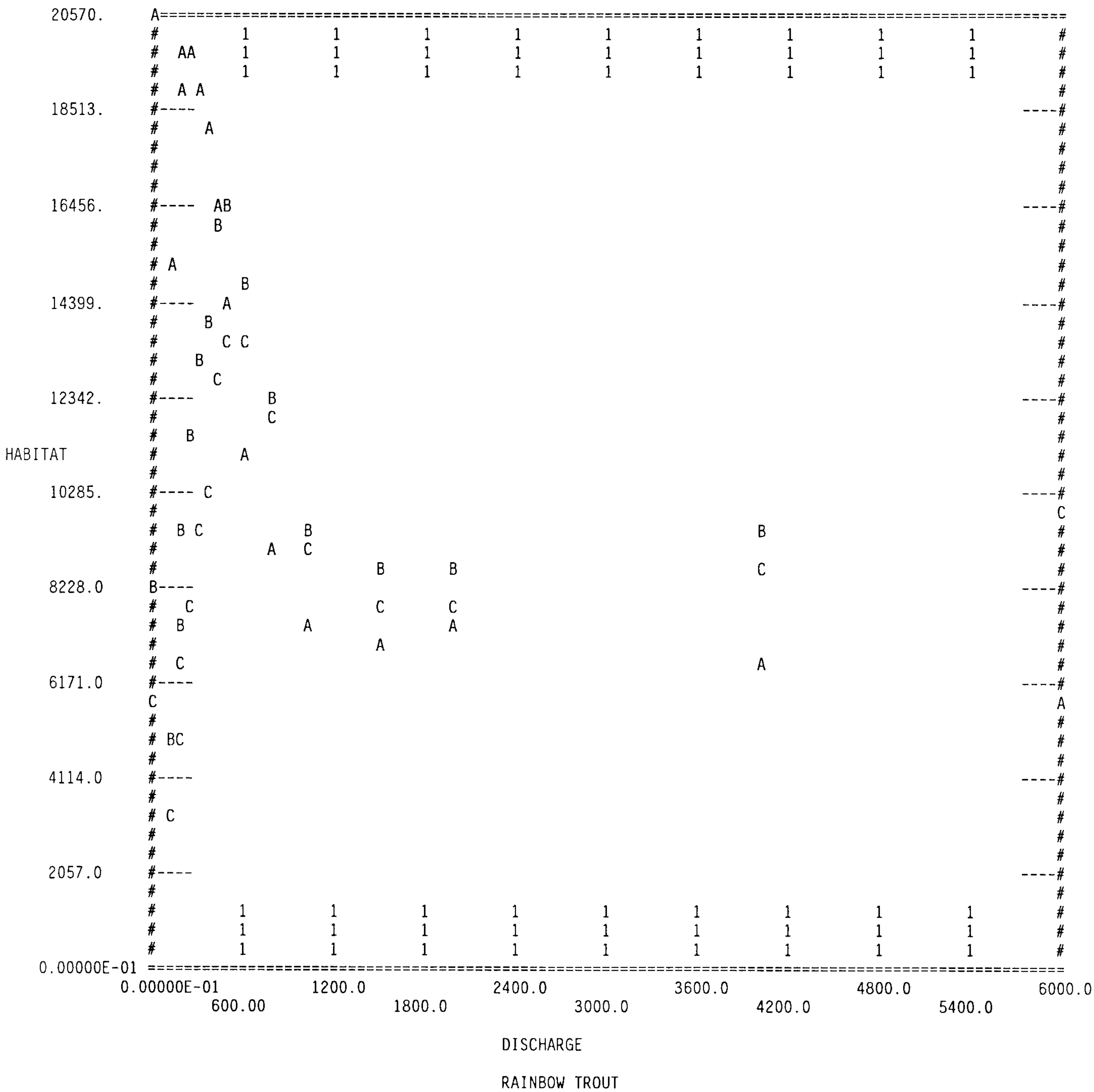


Fig. 3.10. *Continued.*

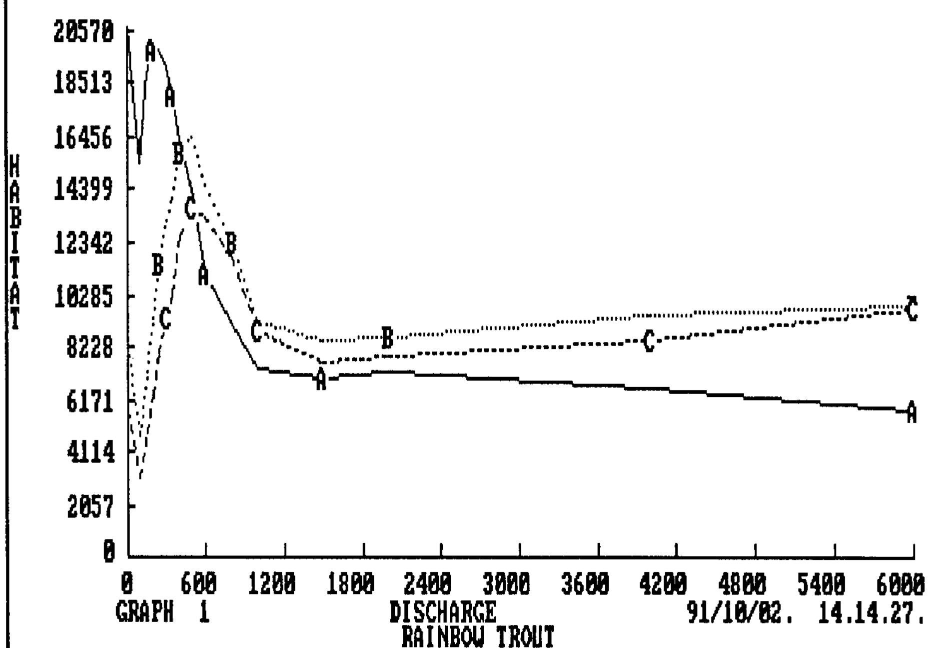


Fig. 3.10. *Continued.*

MRGHQF Program

Introduction

The MRGHQF program extracts up to five life stages from one or two habitat area-versus-streamflow files and creates a new habitat area-versus-streamflow file.

In some situations, the various life stages for a single species can be scattered throughout a number of ZHAQF files. The cause may be any number of reasons—for example, conditional cover was used in the analysis; different options were used in the habitat simulation; or a mixture of curve set ID numbers were used in the species criteria file, which caused the habitat programs to split the life stages into two parts. In this situation, the MRGHQF program could be used to merge results from various sources into a single file for use in the time series analysis.

Another use of the MRGHQF program is to compare the same life stage for a number of species, in which case the life stage becomes the new "species" and the species becomes the new "life stage" in the ZHAQF file.

Running MRGHQF

RMRGHQF, ZHAQFN, ZHAQF, ZHAQF2

ZHAQFN = Habitat-versus-flow file with selected life stages (output).

ZHAQF = Habitat-versus-flow file (input).

ZHAQF2 = Habitat-versus-flow file (input).

> The number and magnitude of flows must be the same on the ZHAQF files being merged. If they are not the same, a message will be printed and the program will terminate.

The two title lines from the input file(s) are displayed.

```
ENTER:  1 TO USE THE TITLE FROM THE FIRST INPUT FILE
        2 TO USE THE TITLE FROM THE SECOND INPUT FILE
        3 TO ENTER A NEW TITLE:

ENTER TWO LINE TITLE:
```

These title lines will be in the merged output file.

> The following prompts will appear for each species record in the ZHAQF file(s). Records are separated by a line of at least 10 asterisks (**********)

The Species and Life Stage lines for the first record in the input file(s) will be displayed.

```
ENTER NUMBER OF LIFE STAGE(S) TO EXTRACT FROM SET 1:

ENTER COLUMN NUMBERS CORRESPONDING TO LIFE STAGE(S) FOR
[—] LIFE STAGE(S):
```

The blank will contain the number entered for the number of life stage(s) to extract from set 1. For example, the following was displayed for set 1:

```
********************
DATA SET 1 IS
SPECIES — RAINBOW TROUT
LIFE STAGE —        FRY                JUVENILE      ADULT
ENTER NUMBER OF LIFE STAGE(S) TO EXTRACT FROM SET 1: 2
ENTER COLUMN NUMBERS CORRESPONDING TO LIFE STAGE(S) FOR
         2 LIFE STAGE(S):
```

If only one ZHAQF file was specified as input, and 1 and 3 are entered here, a new ZHAQF file will be created containing weighted usable area versus flow for fry and adult rainbow trout.

__First ZHAQF file used as input to MRGHQF__:

```
SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
        DISCHARGE      FRY        JUVENILE      ADULT
            10.00    20570.00      8220.00     5780.00
           100.00    15400.00      4770.00     3200.00
           150.00    18880.00      7230.00     4890.00
           200.00    19790.00      9360.00     6410.00
           250.00    19780.00     11470.00     8020.00
           300.00    19110.00     13140.00     9410.00
           350.00    18050.00     14110.00    10400.00
           400.00    16290.00     15850.00    12600.00
           500.00    14470.00     16360.00    13660.00
           600.00    11030.00     14610.00    13380.00
           800.00     9090.00     12310.00    11740.00
          1000.00     7410.00      9270.00     8880.00
          1500.00     6940.00      8490.00     7620.00
          2000.00     7210.00      8630.00     7810.00
          4000.00     6660.00      9480.00     8510.00
          6000.00     5740.00      9890.00     9670.00
***************
```

__Second ZHAQF file used as input to MRGHQF__:

```
SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WA
SAMPLE ZHAQF FILE TO USE WITH THE MRGHQF PROGRAM.
RAINBOW TROUT
        DISCHARGE     SPAWNING     JUVENILE      ADULT
            10.00     2050.00       822.00      578.00
           100.00     1540.00       477.00      320.00
           150.00     1888.00       723.00      489.00
           200.00     1979.00       936.00      641.00
           250.00     1978.00      1147.00      802.00
           300.00     1911.00      1314.00      941.00
           350.00     1805.00      1411.00     1040.00
           400.00     1629.00      1585.00     1260.00
           500.00     1447.00      1636.00     1366.00
           600.00     1103.00      1461.00     1338.00
           800.00      909.00      1231.00     1174.00
          1000.00      741.00       927.00      888.00
          1500.00      694.00       849.00      762.00
          2000.00      721.00       863.00      781.00
          4000.00      666.00       948.00      851.00
          6000.00      574.00       989.00      967.00
```

Fig. 3.11. Sample input files to MRGHQF.

If two ZHAQF files were specified as input, the information in the example would be displayed for both data sets, and the user would specify what life stages to extract from each data set.

If the species names do not match on the two ZHAQF files, then the following prompt will be asked:

```
ENTER NEW SPECIES NAME (40 CHARS), OR '*' TO
USE SPECIES NAME FROM DATA SET 1:
```

This name will be the first line in each record (for the first record in the ZHAQF file, it follows the two title lines).

If the life stage names do not not match on the two ZHAQF files, then the following prompt will be asked:

```
ENTER [—] LIFE STAGE NAME(S) FOR SET 1:
(OR '*' TO USE LIFE STAGE FROM SET 1 (10 CHARS MAX)
```

The blank will contain the number of life stage(s) specified to extract from set 1. If new life stage names are being entered, separate the names with a carriage return.

If two input files were specified:

```
ENTER [—] LIFE STAGE NAME(S) FOR SET 2:
(OR '*' TO USE LIFE STAGE FROM SET 2 (10 CHARS MAX)
```

Figure 3.11 contains two sample input files for the MRGHQF program. Figure 3.12 contains sample output from the MRGHQF program.

Fry, juvenile, and adult from first ZHAQF file; spawning from second ZHAQF file:

```
ZHAQF FILE CREATED BY MRGHQF.  (FRY, JUVENILE, AND ADULT FROM FIRST ZHAQF FILE)
(SPAWNING FROM SECOND ZHAQF FILE)
RAINBOW TROUT
      DISCHARGE      FRY         JUVENILE     ADULT        SPAWNING
* 1       10.00    20570.00      8220.00     5780.00      2050.00
* 2      100.00    15400.00      4770.00     3200.00      1540.00
* 3      150.00    18880.00      7230.00     4890.00      1888.00
* 4      200.00    19790.00      9360.00     6410.00      1979.00
* 5      250.00    19780.00     11470.00     8020.00      1978.00
* 6      300.00    19110.00     13140.00     9410.00      1911.00
* 7      350.00    18050.00     14110.00    10400.00      1805.00
* 8      400.00    16290.00     15850.00    12600.00      1629.00
* 9      500.00    14470.00     16360.00    13660.00      1447.00
*10      600.00    11030.00     14610.00    13380.00      1103.00
*11      800.00     9090.00     12310.00    11740.00       909.00
*12     1000.00     7410.00      9270.00     8880.00       741.00
*13     1500.00     6940.00      8490.00     7620.00       694.00
*14     2000.00     7210.00      8630.00     7810.00       721.00
*15     4000.00     6660.00      9480.00     8510.00       666.00
*16     6000.00     5740.00      9890.00     9670.00       574.00
***************
```

Fry and adult from first ZHAQF file; spawning and juvenile from second ZHAQF file:

```
ZHAQF FILE CREATED BY MRGHQF.  (FRY AND ADULT FROM FIRST ZHAQF FILE)
(SPAWNING AND JUVENILE FROM SECOND ZHAQF FILE)
RAINBOW TROUT
      DISCHARGE      FRY         ADULT        SPAWNING     JUVENILE
* 1       10.00    20570.00      5780.00      2050.00       822.00
* 2      100.00    15400.00      3200.00      1540.00       477.00
* 3      150.00    18880.00      4890.00      1888.00       723.00
* 4      200.00    19790.00      6410.00      1979.00       936.00
* 5      250.00    19780.00      8020.00      1978.00      1147.00
* 6      300.00    19110.00      9410.00      1911.00      1314.00
* 7      350.00    18050.00     10400.00      1805.00      1411.00
* 8      400.00    16290.00     12600.00      1629.00      1585.00
* 9      500.00    14470.00     13660.00      1447.00      1636.00
*10      600.00    11030.00     13380.00      1103.00      1461.00
*11      800.00     9090.00     11740.00       909.00      1231.00
*12     1000.00     7410.00      8880.00       741.00       927.00
*13     1500.00     6940.00      7620.00       694.00       849.00
*14     2000.00     7210.00      7810.00       721.00       863.00
*15     4000.00     6660.00      8510.00       666.00       948.00
*16     6000.00     5740.00      9670.00       574.00       989.00
```

Fig. 3.12. Sample output from the MRGHQF program.

MULHQF Program

Introduction

The MULHQF program weights individual life stages, or multiplies or divides habitat values in a habitat area-versus-streamflow file by a constant.

This program is useful when the habitat area-versus-streamflow function needs to be modified by a constant. For example, an analyst may wish to adjust the function to account for a constant temperature suitability term for all flows. Another situation where the habitat area-versus-streamflow function could be modified by a constant is when either (or both) the habitat area or discharge is scaled to move the function to a new site. The multiplier (or divisor) must be determined by the analyst.

A third case where the MULHQF program would be useful is where each life stage is to be adjusted to an adult (or some other) equivalent. An example of this function is contained in Fig. 3.13.

Running MULHQF

RMULHQF, ZHAQFN, ZHAQF

ZHAQFN = Habitat-versus-flow file with adjusted habitat values (output).

ZHAQF = Habitat-versus-flow file (input).

The two title lines from the original ZHAQF are displayed and the user is prompted to enter two new title lines.

```
ENTER 0 TO MULTIPLY BY A CONSTANT
      1 TO DIVIDE BY A CONSTANT
      2 TO MULTIPLY INDIVIDUAL LIFE STAGES
        BY A CONSTANT:
```

If options 0 or 1 are selected:

```
ENTER CONSTANT MULTIPLIER/DIVISOR FOR AREA -

ENTER CONSTANT MULTIPLIER/DIVISOR FOR DISCHARGE -
```

<u>ZHAQF file used as input to MULHQF</u>:

```
SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
      DISCHARGE       FRY       JUVENILE     ADULT
          10.00   20570.00     8220.00     5780.00
         100.00   15400.00     4770.00     3200.00
         150.00   18880.00     7230.00     4890.00
         200.00   19790.00     9360.00     6410.00
         250.00   19780.00    11470.00     8020.00
         300.00   19110.00    13140.00     9410.00
         350.00   18050.00    14110.00    10400.00
         400.00   16290.00    15850.00    12600.00
         500.00   14470.00    16360.00    13660.00
         600.00   11030.00    14610.00    13380.00
         800.00    9090.00    12310.00    11740.00
        1000.00    7410.00     9270.00     8880.00
        1500.00    6940.00     8490.00     7620.00
        2000.00    7210.00     8630.00     7810.00
        4000.00    6660.00     9480.00     8510.00
        6000.00    5740.00     9890.00     9670.00
***************
```

<u>Output ZHAQF file from MULHQF</u>: The following weights were assigned: 5 for Fry, 1.5 for Juvenile, and 1 for Adult.

```
ZHAQF OUTPUT FILE FROM MULHQF WHEN MULTIPLY INDIVIDUAL LIFE STAGES BY A
CONSTANT OPTION WAS SELECTED.  WEIGHTS= 5 FOR FRY, 1.5 FOR JUVENILE, 1 FOR ADULT
RAINBOW TROUT
      DISCHARGE       FRY       JUVENILE     ADULT
* 1       10.00   102850.00    12330.00     5780.00
* 2      100.00    77000.00     7155.00     3200.00
* 3      150.00    94400.00    10845.00     4890.00
* 4      200.00    98950.00    14040.00     6410.00
* 5      250.00    98900.00    17205.00     8020.00
* 6      300.00    95550.00    19710.00     9410.00
* 7      350.00    90250.00    21165.00    10400.00
* 8      400.00    81450.00    23775.00    12600.00
* 9      500.00    72350.00    24540.00    13660.00
*10      600.00    55150.00    21915.00    13380.00
*11      800.00    45450.00    18465.00    11740.00
*12     1000.00    37050.00    13905.00     8880.00
*13     1500.00    34700.00    12735.00     7620.00
*14     2000.00    36050.00    12945.00     7810.00
*15     4000.00    33300.00    14220.00     8510.00
*16     6000.00    28700.00    14835.00     9670.00
```

Fig. 3.13. Sample output from the MULHQF program.

The area and discharge figures for each species record in the ZHAQF file will be multiplied or divided by the same number.

If option 2 is selected:

The following prompt will appear for each species record in the ZHAQF file. Records are separated by a line of at least 10 asterisks (**********).

```
ENTER WEIGHTS FOR EACH LIFE STAGE OF -
[species line information]
[life stage information]
```

Example:

```
ENTER WEIGHTS FOR EACH LIFE STAGE OF -
RAINBOW TROUT
FRY JUVENILE ADULT
:
```

Responses may be separated by a space, comma, or carriage return.

If the first record in the ZHAQF file contains Total area, the species would be total area and the life stage would be area.

Figure 3.13 is an example of adjusting each life stage to an adult equivalent. The life stage weights entered were 5 for fry, 1.5 for juvenile, and 1.0 for adult. This is to say that each unit of juvenile habitat produces enough to fill one unit of adult habitat.

NRMHQF Program

Introduction

The NRMHQF program normalizes habitat values in a habitat area-versus-streamflow file regarding a given discharge and the corresponding area. If the given discharge is not on the file, it will be added, and habitat values will be calculated by interpolation for the discharge. If the first record in the input file is not area, the user will be prompted to enter area.

This program is useful for moving habitat area-versus-streamflow functions about a watershed. The normalization of the habitat area-versus-streamflow function requires some logic from the analyst to use normalization to move a habitat area-versus-streamflow function.

Running NRMHQF

RNRMHQF, ZHAQFN, ZHAQF

ZHAQFN = Normalized habitat-versus-flow file (output).

ZHAQF = Habitat-versus-flow file (input).

The two title lines from the ZHAQF file are displayed.

```
ENTER  1 TO CHANGE TITLE
       0 TO LEAVE TITLE AS IT IS:
```

If 1 is entered to change title:

```
ENTER 2 NEW TITLE LINES (80 CHARS MAX):

ENTER NORMALIZATION FLOW:
```

In the sample output in Fig. 3.14, the mean annual flow and the surface area at the mean annual flow were used (499 cfs and 275,800 ft^2/ 1,000 ft—average width of 276 feet.)

If the discharge entered is not in the ZHAQF file, it will be added, and habitat values will be calculated by interpolation for the discharge.

If Total area is not the first record in the ZHAQF file, the following prompt will appear:

```
ENTER TOTAL AREA CORRESPONDING TO NORMALIZATION FLOW:
```

Since total area was not included in the sample input file, 275,800 was entered as it was the surface area at the mean annual flow of 499 cfs.

ZHAQF FILE USED AS INPUT TO NRMHQF:

SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT

DISCHARGE	FRY	JUVENILE	ADULT
10.00	20570.00	8220.00	5780.00
100.00	15400.00	4770.00	3200.00
150.00	18880.00	7230.00	4890.00
200.00	19790.00	9360.00	6410.00
250.00	19780.00	11470.00	8020.00
300.00	19110.00	13140.00	9410.00
350.00	18050.00	14110.00	10400.00
400.00	16290.00	15850.00	12600.00
500.00	14470.00	16360.00	13660.00
600.00	11030.00	14610.00	13380.00
800.00	9090.00	12310.00	11740.00
1000.00	7410.00	9270.00	8880.00
1500.00	6940.00	8490.00	7620.00
2000.00	7210.00	8630.00	7810.00
4000.00	6660.00	9480.00	8510.00
6000.00	5740.00	9890.00	9670.00

****

OUTPUT FROM NRMHQF: Normalization flow of 499 cfs with a corresponding total area of 275,800 ft^2/1000 ft.

SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WA NORMALIZED ZHAQF FILE
(499=NORMALIZATION FLOW; 275800=TOTAL AREA CORRESPONDING TO FLOW OF 499 CFS)
RAINBOW TROUT

	DISCHARGE	FRY	JUVENILE	ADULT
* 1	0.02	0.07	0.03	0.02
* 2	0.20	0.06	0.02	0.01
* 3	0.30	0.07	0.03	0.02
* 4	0.40	0.07	0.03	0.02
* 5	0.50	0.07	0.04	0.03
* 6	0.60	0.07	0.05	0.03
* 7	0.70	0.07	0.05	0.04
* 8	0.80	0.06	0.06	0.05
* 9	1.00	0.05	0.06	0.05
*10	1.00	0.05	0.06	0.05
*11	1.20	0.04	0.05	0.05
*12	1.60	0.03	0.04	0.04
*13	2.00	0.03	0.03	0.03
*14	3.01	0.03	0.03	0.03
*15	4.01	0.03	0.03	0.03
*16	8.02	0.02	0.03	0.03
*17	12.02	0.02	0.04	0.04

****

Fig. 3.14. Sample output from the NRMHQF file.

SUMHQF Program

Introduction

The SUMHQF program sums conditional cover columns in a ZHAQF file into one habitat area-versus-streamflow figure for each life stage. SUMHQF is run when conditional cover curves were used as input to the habitat simulation programs. Up to five life stages can be grouped in each record (section).

Running SUMHQF

RSUMHQF, ZHAQF, ZHAQFN

ZHAQF = Habitat-versus-flow file (input).

ZHAQFN = Modified habitat-versus-flow file with columns summed (output).

Figure 3.15 contains a habitat-versus-flow (ZHAQF) file that was generated by a habitat simulation program using conditional cover curves as input.

The results of running SUMHQF on this file and summing the life stages and grouping the life stages together is shown in Fig. 3.16.

The species and life stage lines for the first record in the ZHAQF file are printed out. If the first record in the file contains total area information, that record is skipped, as there is nothing to sum and no other information should be grouped with it.

Example:

```
SPECIES NAME IS:  WINTER STEELHEAD - FRY
LIFE STAGE NAME IS: NO COV OHC SM OBJ LG OBJ COMBO

DO YOU WANT TO SUM THESE LIFE STAGES?
   0) TO SUM LIFE STAGES
   1) TO LEAVE UNCHANGED
Choice:
```

If 0 is entered to sum life stages—

```
ENTER NEW SPECIES NAME OR '*' TO LEAVE UNCHANGED (MAX 40 CHAR):
```

In this case, you would probably want to change the species name to "Winter steelhead" versus "Winter steelhead—fry".

```
ENTER NEW LIFE STAGE NAME OR '*' TO USE [—] (MAX 10 CHAR):
```

The blank would contain the first life stage name from the record (NO COV in example). In this example, you would probably want to change the life stage name to Fry.

> The following prompt would appear after the first species record, but before the series of prompts for that record. Records are separated by a line of at least 10 asterisks (**********).

```
DO YOU WANT THIS LIFE STAGE TO BE GROUPED
WITH THE PREVIOUS LIFE STAGE? (Y/N):
```

This allows grouping up to five life stages for one species into one record instead of having separate records for each life stage of a species.

```
ALTMAR REACH OF SALMON RIVER, NEW YORK
COMPOSITE OF VELOCITIES AND SECTIONS AS ISLANDS
TOTAL AREA
       DISCHARGE  AREA
 * 1       25.00   155830.02
 * 2       50.00   177486.70
 * 3      100.00   196136.69
 * 4      200.00   216444.92
 * 5      350.00   255153.21
 * 6      500.00   275933.49
 * 7      750.00   290595.31
 * 8     1000.00   299066.76
 * 9     1500.00   314227.33
 *10     2000.00   324867.37
 *11     3000.00   336215.01
 *12     4000.00   342061.39
 *13     6000.00   353205.87
 ***************
 WINTER STEELHEAD - FRY
       DISCHARGE    NO COV      OHC        SM OBJ      LG OBJ      COMBO
 * 1       25.00   36804.74   16306.65        .00    21789.52    25244.11
 * 2       50.00   42488.03   29452.52      77.77    27011.82    30049.86
 * 3      100.00   49470.16   52286.84     497.36    36938.97    38996.91
 * 4      200.00   57006.86   75435.19    1679.59    54869.38    55732.63
 * 5      350.00   53623.63   72839.97   11397.30    72371.30    73694.66
 * 6      500.00   57625.58   80676.66   13611.55    86036.53    85775.26
 * 7      750.00   42776.20   76005.57   17616.62    97044.67    88448.59
 * 8     1000.00   44224.03   66899.98   17214.27    99281.85    87951.39
 * 9     1500.00   33173.15   51386.66   11574.54    93601.19    84916.85
 *10     2000.00   30239.80   45081.72    9715.15    89563.80    78886.59
 *11     3000.00   41442.36   52683.58    8968.61    99457.46    85294.71
 *12     4000.00   40432.90   52567.05    9091.70    91380.50    74053.72
 *13     6000.00   38948.23   52587.85    9177.92    75138.07    53160.54
 ***************
 WINTER STEELHEAD - JUVENILE
       DISCHARGE    NO COV      OHC        SM OBJ      LG OBJ
 * 1       25.00    8571.75    8400.63    8299.07    15146.13
 * 2       50.00    9510.26    9713.29   10403.51    15011.19
 * 3      100.00   10862.79   12096.84   12639.01    13434.02
 * 4      200.00   11115.56   17193.59   13461.92     9264.43
 * 5      350.00    8391.54   20679.94   13209.33     7143.46
 * 6      500.00    7582.15   22703.33   15003.20     5988.42
 * 7      750.00   10476.25   33439.54   17078.55     5783.53
 * 8     1000.00   16027.40   43305.33   18235.65     5270.12
 * 9     1500.00   19676.19   47712.90   16389.55     5490.25
 *10     2000.00   17830.52   47498.62   14661.03     4733.12
 *11     3000.00     367.64   27747.65   10016.22     1064.70
 *12     4000.00     314.97   23107.39    9086.60      481.36
 *13     6000.00     312.27   19566.01    7995.55      183.39
 ***************
 WINTER STEELHEAD - ADULT
       DISCHARGE    NO COV      OHC        SM OBJ      LG OBJ      COMBO
 * 1       25.00   43608.82    6196.79   25572.92    68915.12    56589.43
 * 2       50.00   52224.68   10751.89   30262.63    73718.21    60120.13
 * 3      100.00   61181.60   16278.15   34279.03    72336.25    59780.00
 * 4      200.00   66805.23   20009.82   35725.55    64934.86    52818.65
 * 5      350.00   70469.46   18052.48   39403.82    64219.78    54584.10
 * 6      500.00   72489.76   17356.70   42966.28    64386.38    55091.62
 * 7      750.00   70860.33   18509.72   47208.83    50221.78    45213.51
 * 8     1000.00   64313.60   15762.86   48012.24    39843.04    38723.45
 * 9     1500.00   56186.58   11580.82   48662.42    30564.08    34261.80
 *10     2000.00   53859.44   11422.69   47223.98    29356.40    33701.92
 *11     3000.00   51531.37    9654.18   42808.11    34230.58    30885.99
 *12     4000.00   50553.59    9889.69   41964.97    33305.82    30155.11
 *13     6000.00   49788.69    9994.45   43444.38    32462.49    29209.57
 ***************
```

Fig. 3.15. ZHAQF file generated using conditional cover curves.

```
 ALTMAR REACH OF SALMON RIVER, NEW YORK
 COMPOSITE OF VELOCITIES AND SECTIONS AS ISLANDS
 TOTAL AREA
      DISCHARGE  AREA
* 1       25.00   155830.02
* 2       50.00   177486.70
* 3      100.00   196136.69
* 4      200.00   216444.92
* 5      350.00   255153.21
* 6      500.00   275933.49
* 7      750.00   290595.31
* 8     1000.00   299066.76
* 9     1500.00   314227.33
*10     2000.00   324867.37
*11     3000.00   336215.01
*12     4000.00   342061.39
*13     6000.00   353205.87
***************
WINTER STEELHEAD
      DISCHARGE  FRY          JUVENILE     ADULT
* 1       25.00   100145.02     40417.58    200883.09
* 2       50.00   129080.00     44638.25    227077.53
* 3      100.00   178190.23     49032.66    243855.03
* 4      200.00   244723.64     51035.50    240294.09
* 5      350.00   283926.84     49424.27    246729.62
* 6      500.00   323725.56     51277.10    252290.73
* 7      750.00   321891.66     66777.87    232014.17
* 8     1000.00   315571.50     82838.49    206655.20
* 9     1500.00   274652.37     89268.89    181255.70
*10     2000.00   253487.06     84723.29    175564.44
*11     3000.00   287846.72     39196.21    169110.22
*12     4000.00   267525.87     32990.32    165869.17
*13     6000.00   229012.59     28057.22    164899.56
***************
```

Fig. 3.16. ZHAQF file with life stages summed using SUMHQF.

Chapter 4.
Transferring Streamflow Data

Introduction

In many instream flow investigations, the site where the analysis is desired is not the same location as where streamflow data are available. Usually it is the responsibility of the project sponsor to transfer the streamflow data from the location where they are available to the site where the instream flow analysis is desired. In some situations, the instream flow analyst needs to do the transferral. The programs presented in this section will allow the instream flow analyst to make relatively simple transferrals. The programs are based on the work of one of the authors while working with the Washington Department of Ecology. These programs are relatively simple; users interested in more complex approaches should contact experts in the area or develop their own programs.

The TRANMR and TRANMN programs are available to make approximate estimations of streamflow at ungaged river segments (ungaged sites) by transferring data for a gaged location. The TRANMR program uses readily available information to make the streamflow transferal or it uses regional statistics that may be available from the U.S. Geological Survey. The TRANMN program requires measured data to develop a relation between the two sites.

The TRANTS program is available to investigate the effect of longer records on the annual flows. In many situations, the daily and monthly flows are significantly regulated by humans, but the annual flows are reasonably representative of what the flows would be naturally. Exceptions to this are large dams and irrigation projects. These regulated sites are often the sites with the longest records. Using the annual flows at the longer record site to extend the annual flow record at a site being studied allows the analyst to determine how representative the available record is.

Programs to Transfer Streamflow Data

Program Name	Batch/Procedure Filename	Function	Program Description
TRANTS	**RTRANTS**	Transferring streamflow data	Transfers an annual streamflow file from a long record site to a short record site using the equation Qnew = A*(Qold)**B. **RTRANTS, ZANTS, ZANTSN** **ZANTS** = Annual time series file containing streamflow data from a long record site (input). **ZANTSN** = Transferred annual time series file for a short record site (output).

Program Name	Batch/Procedure Filename	Function	Program Description
TRANMN	**RTRANMN**	Transferring streamflow data	Transfers a monthly streamflow file from a gaged site to an ungaged site using the equation Qnew = A*(Qold)**B with options to use different A and B values for different flow ranges or to compute A and B using given old and new flows. **RTRANMN, ZMONQ, ZMONQN, ZOUT** **ZMONQ** = Monthly streamflow file (in USGS or NWDC format) for a gaged site (input). **ZMONQN** = Monthly streamflow file with calculated flows for the ungaged site (output). **ZOUT** = TRANMN results (output).
TRANMR	**RTRANMR**	Transferring streamflow data	Transfers a monthly streamflow file for a gaged site to an ungaged site using one of the following methods: (1) drainage area ratio; (2) drainage area and precipitation ratio; or (3) regional statistics method. **RTRANMR, ZMONQ, ZMONQN, ZOUT** **ZMONQ** = Monthly streamflow file (in USGS or NWDC format) for a gaged site (input). **ZMONQN** = Monthly streamflow file with calculated flows for the ungaged site (output). **ZOUT** = TRANMR results (output).

TRANTS Program

Introduction

The TRANTS program is used to investigate the effect of longer records on the annual flows. In many situations, the daily and monthly flows are significantly regulated by humans, but the annual flows are reasonably representative of what the flows would be naturally. Exceptions to this are large dams and irrigation projects. These regulated sites are often the sites with the longest records. Using the annual flows at the longer record site to extend the annual flow record at a site being studied allows the analyst to determine how representative the available record is.

Running TRANTS

RTRANTS, ZANTS, ZANTSN

ZANTS = Annual time series file containing streamflow data from a long record site (input).

ZANTSN = Transferred annual time series file for a short record site (output).

```
ENTER TWO NEW TITLE LINES FOR THE SHORT RECORD SITE:
TRANTS TRANSFERS ANNUAL FLOWS, USING THE EQUATION
          QNEW = A*(QOLD)**B

ENTER A AND B:
```

These values are obtained from an analysis of the relation between the two sites. Figure 4.1 is a diagram of the relation of the annual streamflow of the Black River at Watertown, New York (long record site), and the annual streamflow at Sandy Creek near Adams, New York (short record site).

In this analysis, A is 15 and B is 1.

The AQBKWAT.DAT file on your sample disk contains the annual streamflow data for the Black River at Watertown, New York.

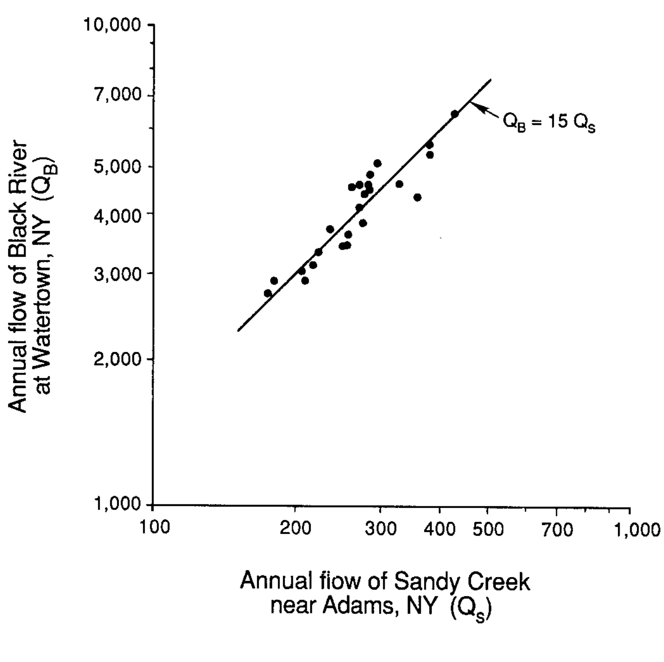


Fig. 4.1. Diagram of the relation of the annual streamflow of the Black River at Watertown, New York, and the annual streamflow at Sandy Creek near Adams, New York.

TRANMN Program

Introduction

The TRANMN program transfers monthly flows from a gaged (measured) site to an ungaged site using the equation

Qnew = A*(Qold)**B

with options to use different A and B values for different flow ranges or to compute A and B using given old and new flows.

The sample output from the TRANMN program (Figs. 4.3 and 4.4) was generated using gaged streamflow data from Sandy Creek near Adams, New York, and transferring that data to the West Branch of the Oswegatchie River near Harrisville, New York, using two different options in the TRANMN program. The MQSANCK.DAT file on your sample disk contains the gaged streamflow data for Sandy Creek near Adams, New York.

Running TRANMN

RTRANMN, ZMONQ, ZMONQN, ZOUT

ZMONQ = Monthly streamflow file (in USGS or NWDC format) for a gaged site (input).

ZMONQN = Monthly streamflow file with calculated flows for the ungaged site (output).

ZOUT = TRANMN results (output).

The two title lines from the input streamflow file will be displayed.

```
ENTER TWO TITLE LINES FOR UNGAGED SITE:

ENTER STATION NUMBER FOR UNGAGED SITE (10 CHAR MAX):
```

```
TRANMN USES THE EQUATION Qnew = A*Qold**B
ENTER:    0 = TO ENTER A AND B FOR ALL FLOWS
          1 = TO ENTER DIFFERENT A AND B VALUES FOR
              DIFFERENT RANGES OF FLOWS
          2 = TO ENTER PAIRS OF OLD AND NEW FLOWS TO
              USE TO COMPUTE A AND B.
```

If option 0 is selected:

```
ENTER A AND B:
```

Output is similar to option 1 except that only one equation is used.

If option 1 is selected:

```
ENTER THE NUMBER OF FLOW RANGES TO BE USED (6 MAX):
```

To generate the output in Fig. 4.3, "2" was entered.

Figure 4.2 is a diagram showing the development of the relations used in the TRANMN program.

The points in Fig. 4.2 are from the daily values of streamflow published by the U.S. Geological Survey. Common sources for the ungaged sites are short records, miscellaneous streamflow measurements, or streamflow data from the instream flow study. One concern with the data shown in Fig. 4.2 is that the best relation for the winter period is $Q_W = 1.91\ Q_S$ for all flows, and during summer, $Q_W = 22.9\ Q_S^{0.6}$ for flows less than 560. This problem can be solved by using the first equation for all flows (option 0) for one run of TRANMN and both equations (option 1) for a second run. The SELMTS program (Chapter 8) could then be used to merge the two files into one file with the months of November through April from the first file and May through October from the second file.

The user must develop the logic of how to approach the problem and must develop the transfer equations. For assistance, see Riggs (1972).

```
ENTER THE UPPER BOUND FOR THE [-] FLOW RANGES
FROM LEAST TO GREATEST:
```

520 and 10000 were entered.

```
ENTER A AND B FOR THE FLOW RANGE FROM
0.0000000E-01 TO [-] (520 in this case):
```

The A and B values entered were 22.9 and .6.

```
ENTER A AND B FOR THE FLOW RANGE FROM
520.0000000 TO 10000.0000000:
```

The A and B values entered were 1.91 and 1.

If option 2 is selected:

```
ENTER NUMBER OF POINTS TO BE USED FOR CALIBRATION:
```

To generate the output in Fig. 4.4, "24" was entered.

The data used here are the same as shown in Fig. 4.2. Compare Figs. 4.3 and 4.4, both of which are based on the same data, but use a different approach to using the data. It would be better to have used the two-curves approach (option 1). The user must obtain the data used in the analysis and select a single curve.

```
ENTER THE [-] PAIRS (QOLD, QNEW):

ENTER  1 TO PLOT GIVEN FLOW PAIRS
       0 OTHERWISE.
```

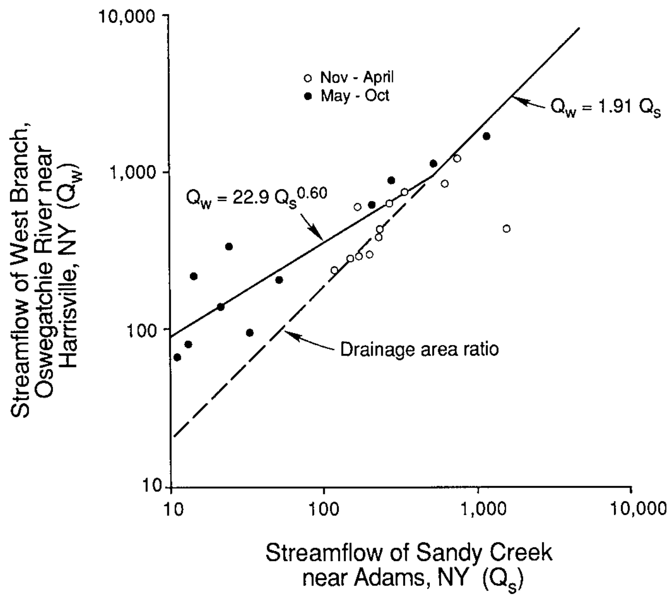


Fig. 4.2. Diagram of the relation of the streamflow of Sandy Creek near Adams, New York, to the streamflow of the West Branch Oswegatchie River near Harrisville, New York.

ZOUT file when option 1 was selected:

```
USING DIFFERENT A AND B VALUES FOR 2 FLOW RANGES
    RANGE NUMBER      LOWER BOUNDARY      UPPER BOUNDARY       A VALUE       B VALUE

         1                  0.00              520.00             22.90          0.60
         2                520.00            10000.00              1.91          1.00
```

ZMONQN file when option 1 was selected:

```
TRANSFERRED STREAMFLOW DATA FROM SANDY CREEK NEAR ADAMS, NY TO
WEST BRANCH OSWEGATCHIE RIVER NEAR HARRISVILLE, NY USING TRANMN, OPTION 1
04262500      1958 1   211.98  700.37    1135  516.19  388.48  802.48
04262500      1958 2   894.04  517.69  392.98  366.93  462.01  791.80
04262500      1959 1   638.76  590.35  446.15  847.79  652.47    1082
04262500      1959 2     2013  516.64  266.06  261.78  228.45  101.50
04262500      1960 1   374.62  800.26  917.70  509.45  882.85  762.92
04262500      1960 2     1921  495.99  543.54  174.19   91.22   52.29
04262500      1961 1   150.27  353.34  323.87  309.71  944.51    1302
04262500      1961 2     1357  468.01  433.64  235.64   93.50   98.78
04262500      1962 1   182.20  438.53  667.77  771.36  455.66    1216
04262500      1962 2     1333  457.38  145.92  150.51  270.91  214.93
04262500      1963 1   374.28  455.51  382.33  350.00  379.86    1554
04262500      1963 2     2267  746.27  237.64   93.45  163.93   65.34
04262500      1964 1    64.10  536.99  594.29  733.47  424.95    1524
04262500      1964 2   974.02  523.37  229.25   87.84   88.63   63.55
04262500      1965 1   114.45  374.58  701.71  454.01  903.80  553.57
04262500      1965 2     1182  375.30  182.51  106.27  133.78  346.96
04262500      1966 1   715.43  915.63  993.51  560.48  658.85    1384
04262500      1966 2   770.98  360.26  183.71   69.82  109.93  223.19
04262500      1967 1   196.62  459.43    1039  800.82  421.16  451.82
04262500      1967 2   866.70  605.80  215.27  149.48   90.73  197.20
04262500      1968 1   653.91    1235  653.20  429.86  668.15    1091
04262500      1968 2   717.47  511.01  308.25  157.33   77.63  169.78
04262500      1969 1   369.56    1150  842.06  811.93  646.50  764.33
04262500      1969 2     1532  710.06  545.43  216.96  116.51   68.70
04262500      1970 1   128.85  562.40  655.29  402.28  678.57  716.33
04262500      1970 2     1992  608.60  311.47  299.45  112.09  139.13
04262500      1971 1   526.68  690.16  601.06  422.28  456.13  840.74
04262500      1971 2     2204    1109  264.72  168.51  198.64  248.25
04262500      1972 1   176.35  545.32  832.13  670.38  524.09    1166
04262500      1972 2     1676  729.77  768.26  900.37  388.21  184.57
04262500      1973 1   402.02  805.61  975.14    1003  871.96    1081
04262500      1973 2     1090  644.72  339.57  115.20  103.17  136.23
04262500      1974 1   240.28  627.61    1514  891.17  568.70  766.94
04262500      1974 2     1447  880.17  336.76  245.24  250.32  193.88
04262500      1975 1   236.74  797.56  841.98  812.45  763.28    1203
04262500      1975 2     1227  402.67  360.39  165.92  120.78  644.90
04262500      1976 1   562.06  763.00  866.48  698.45    1753    1933
04262500      1976 2   819.31    1405  627.91  431.18  438.40  676.59
04262500      1977 1     1084  754.79  743.63  392.36  493.33    3048
04262500      1977 2     1572  397.46  185.25  109.10  462.72  688.26
04262500      1978 1   967.85    1268    1040    1089  552.06  940.97
04262500      1978 2     2361  511.13  255.75   97.32   74.29  207.65
04262500      1979 1   333.62  385.91  611.13  898.61  499.64    2126
04262500      1979 2   935.58  490.84  255.83  101.65  185.76  504.27
04262500      1980 1   760.39  901.46  964.19  550.91  268.33    1290
04262500      1980 2     1075  445.54  292.59  382.20  189.45  257.86
04262500      1981 1   849.42  958.98  963.68  370.90    2227  705.51
04262500      1981 2   828.72  559.39  300.81  416.47  625.81  659.82
04262500      1982 1     1003  792.44  472.74  548.20  412.58    1121
04262500      1982 2     1503  463.87  555.71  225.83  199.68  392.21
```

Fig. 4.3. Sample output when Option 1 is selected in the TRANMN program.

ZOUT file when option 2 was selected:

```
DATE - 90/07/18.     H 04250750     434848076043000363604SSW04140102 128.00          523.71  PROGRAM - TRANMN
TIME - 09.38.35.     N 04250750     SANDY CREEK NEAR ADAMS, N. Y.                              PAGE - 1

 USING FLOW REGRESSION BASED ON 24 USER DEFINED PAIRS

      POINT        OLD FLOW        NEW FLOW

          1          161.00          612.00
          2         1580.00          425.00
          3          118.00          245.00
          4          536.00         1160.00
          5          729.00         1290.00
          6          231.00          433.00
          7          327.00          763.00
          8          210.00          628.00
          9          164.00          296.00
         10          150.00          292.00
         11          194.00          302.00
         12          278.00          696.00
         13          229.00          388.00
         14          620.00          860.00
         15         1150.00         1780.00
         16          275.00          921.00
         17          267.00          623.00
         18           51.00          216.00
         19           21.00          143.00
         20           13.00           80.00
         21           14.00          222.00
         22           24.00          341.00
         23           33.00           95.00
         24           11.00           66.00

     TITLE OF GAGED SITE IS -

   H 04250750       434848076043000363604SSW04140102 128.00         523.71
   N 04250750       SANDY CREEK NEAR ADAMS, N. Y.

TITLE OF UNGAGED SITE IS -

   TRANSFERRED STREAMFLOW DATA FROM SANDY CREEK NEAR ADAMS, NY TO
   WEST BRANCH OSWEGATCHIE RIVER NEAR HARRISVILLE, NY USING TRANMN-OPTION2

THE REGRESSION RELATIONSHIP IS -

     QNEW = .297E+02 * QOLD **     0.519

        CORRELATION COEFFICIENT =0.8507
        STANDARD ERROR OF ESTIMATE = 0.0415
```

ZMONQ file when option 2 was selected:

Fig. 4.4. Sample output when Option 2 is selected in the TRANMN program.

ZMONQ file when option 2 was selected:

```
TRANSFERRED STREAMFLOW DATA FROM SANDY CREEK NEAR ADAMS, NY TO
WEST BRANCH OSWEGATCHIE RIVER NEAR HARRISVILLE, NY USING TRANMN-OPTION 2
04262500    1958 1   203.27  571.03  815.27  438.66  343.12  642.32
04262500    1958 2   705.18  439.76  346.55  326.61  398.58  634.92
04262500    1959 1   527.35  492.63  386.72  673.54  537.12  795.12
04262500    1959 2     1097  438.99  247.38  243.94  216.85  107.56
04262500    1960 1   332.51  640.78  721.28  433.71  697.55  614.86
04262500    1960 2     1071  423.79  458.68  171.54   98.08   60.64
04262500    1961 1   150.99  316.12  293.20  282.09  739.46  875.31
04262500    1961 2   894.42  403.05  377.33  222.74  100.19  105.06
04262500    1962 1   178.34  381.01  547.99  620.73  393.84  844.99
04262500    1962 2   886.12  395.12  147.20  151.19  251.27  205.71
04262500    1963 1   332.25  393.73  338.42  313.54  336.53  959.41
04262500    1963 2     1167  603.24  224.37  100.14  162.78   73.51
04262500    1964 1    72.30  453.90  495.47  594.29  370.79  949.96
04262500    1964 2   759.39  443.93  217.51   94.93   95.66   71.76
04262500    1965 1   119.33  332.48  571.98  392.61  711.83  465.99
04262500    1965 2   832.67  333.03  178.61  111.91  136.56  311.18
04262500    1966 1   581.63  719.88  760.82  471.01  541.66  903.55
04262500    1966 2   620.46  321.46  179.62   77.84  115.24  212.53
04262500    1967 1   190.47  396.65  778.54  641.17  367.93  390.96
04262500    1967 2   686.50  503.75  205.99  150.30   97.62  190.97
04262500    1968 1   538.15  851.68  537.64  374.48  548.26  798.71
04262500    1968 2   583.06  434.86  280.94  157.10   85.31  167.79
04262500    1969 1   328.63  820.66  669.60  648.84  532.87  615.84
04262500    1969 2   952.30  577.86  460.06  207.39  121.18   76.76
04262500    1970 1   132.19  472.40  539.13  353.63  555.64  582.27
04262500    1970 2     1091  505.76  283.48  274.00  117.19  141.26
04262500    1971 1   446.35  563.83  500.34  368.77  394.19  668.70
04262500    1971 2     1150  805.57  246.30  166.70  192.17  233.00
04262500    1972 1   173.38  459.97  662.77  549.84  444.46  826.67
04262500    1972 2   997.84  591.70  618.57  709.49  342.91  180.35
04262500    1973 1   353.43  644.48  760.14  764.75  690.11  794.84
04262500    1973 2   798.42  531.60  305.45  120.00  109.09  138.71
04262500    1974 1   226.53  519.39  946.51  703.23  476.98  617.65
04262500    1974 2   924.48  695.72  303.26  230.56  234.68  188.18
04262500    1975 1   223.64  638.91  669.55  649.20  615.11  840.02
04262500    1975 2   848.90  353.92  321.57  164.49  125.00  531.73
04262500    1976 1   472.16  614.91  686.35  569.69    1021    1074
04262500    1976 2   653.94  910.59  519.60  375.48  380.91  554.24
04262500    1977 1   796.03  609.19  601.39  346.08  421.82    1361
04262500    1977 2   965.33  349.96  180.92  114.49  399.10  562.49
04262500    1978 1   755.23  863.31  779.16  797.72  464.89  737.06
04262500    1978 2     1192  434.94  239.07  103.72   82.14  199.68
04262500    1979 1   300.81  341.16  507.58  708.29  426.48    1129
04262500    1979 2   733.41  419.98  239.14  107.70  181.35  429.89
04262500    1980 1   613.09  710.24  752.76  464.05  249.21  871.29
04262500    1980 2   792.68  386.26  268.56  338.32  184.46  240.78
04262500    1981 1   674.66  749.24  752.41  329.65    1156  574.66
04262500    1981 2   660.43  470.22  275.07  364.38  518.10  542.35
04262500    1982 1   764.41  635.37  406.56  462.08  361.44  810.09
04262500    1982 2   943.08  399.96  467.54  214.70  193.04  345.97
```

Fig. 4.4. *Continued.*

TRANMR Program

Introduction

The TRANMR program transfers a monthly streamflow file for a gaged (measured) site to an ungaged site using one of the following methods: drainage area ratio, drainage area and precipitation ratio, or the regional statistics method.

The TRANMR program was used to transfer gaged streamflow data from Sandy Creek near Adams, New York, to (1) the Salmon River between the Salmon River Reservoir and Pulaski using the drainage area ratio only, and (2) the Salmon River at the Salmon River Reservoir using the drainage area and precipitation ratio. The MQSANCK.DAT file on your sample disk contains the gaged streamflow data for Sandy Creek near Adams, New York. Figure 4.5 contains sample output from the TRANMR program.

The following data is needed to do the streamflow transferrals.

Sandy Creek near Adams, New York:

Drainage area: 128 square miles
Precipitation: 40 inches

Salmon River between Salmon River Reservoir and Pulaski:

Drainage area: 66 square miles

Salmon River at Salmon River Reservoir:

Drainage area: 191 square miles
Precipitation: 52 inches

Running TRANMR

RTRANMR, ZMONQ, ZMONQN, ZOUT

ZMONQ = Monthly streamflow file (in USGS or NWDC format) for a gaged site (input).

ZMONQN = Monthly streamflow file with calculated flows for an ungaged section of stream (output).

ZOUT = TRANMR results (output).

```
ENTER   1 TO USE DRAINAGE AREA RATIO ONLY
        2 TO USE DRAINAGE AREA AND PRECIPITATION RATIO
        3 TO USE THE REGIONAL STATISTICS METHOD
```

The two title lines from the input streamflow file will be displayed.

```
ENTER TWO TITLE LINES FOR UNGAGED SITE:

ENTER STATION NUMBER FOR UNGAGED SITE (10 CHAR MAX):

ENTER MONTH INDEX FOR FIRST MONTH OF EACH YEAR
(JAN.=1, OCT.=10, ETC.):
```

This labels the first month on the input data set—for example, if the data in the input file is in water years (beginning in October), 10 would be entered here.

If 1 is entered to use drainage area ratio only:

```
ENTER DRAINAGE AREA FOR UNGAGED SITE:

ENTER DRAINAGE AREA FOR GAGED SITE:
```

```
DATE - 90/07/18.    H 04250750    34848076043000363604 5SW04140102 128.00        523.71     PROGRAM - TRANMR
TIME - 15.36.06.    N 04250750    SANDY CREEK NEAR ADAMS, N. Y.                                PAGE -    2

         CALCULATED FLOWS FOR UNGAGED SITE -                 DRAINAGE AREA =        191.0
                                                     BASIN PRECIPITATION =        52.00

                  TRANSFERRED STREAMFLOW DATA FROM SANDY CREEK NEAR ADAMS, NY TO
                  THE SALMON RIVER AT THE SALMON RIVER RESERVOIR (TRANMR-OPTION2)
```

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1958	79.17	580.21	1152.89	348.92	217.26	727.95	871.57	350.61	221.47	197.55	290.05	711.86
1959	497.67	436.41	273.63	797.72	515.59	1098.57	2044.60	349.42	115.61	112.53	89.68	23.20
1960	204.50	724.59	910.35	341.35	853.47	669.13	1951.48	326.46	380.27	57.07	19.42	7.68
1961	44.62	185.51	160.44	148.92	955.10	1322.22	1378.45	296.35	260.97	94.43	20.23	22.17
1962	61.51	265.89	535.90	681.51	283.43	1235.31	1353.88	285.22	42.48	44.73	119.15	81.01
1963	204.19	283.28	211.56	182.60	209.29	1578.10	2302.59	644.96	95.77	20.21	51.58	11.13

Fig. 4.5. Partial ZOUT file when option 2 was selected in the TRANMR program to transfer data from Sandy Creek near Adams, NY to the Salmon River at the Salmon River Reservoir.

If 2 is entered to use drainage area and precipitation ratio:

```
ENTER DRAINAGE AREA FOR UNGAGED SITE:

ENTER PRECIPITATION FOR UNGAGED SITE:

ENTER DRAINAGE AREA FOR GAGED SITE:

ENTER PRECIPITATION FOR GAGED SITE:
```

If 3 is entered to use the regional statistics method:

```
ENTER 12 ESTIMATED MONTHLY MEAN FLOWS FOR UNGAGED SITE:

ENTER 12 ESTIMATED MONTHLY STANDARD DEVIATION OF FLOWS AT
UNGAGED SITE:
```

The regional statistics method requires a study using existing data to determine a relation between the mean monthly flow and watershed characteristics and between the monthly standard deviation of flows and watershed characteristics. It is outside the scope of this manual to explain how to develop the equations; however, they are sometimes published in U.S. Geological Survey reports.

Chapter 5. Water Resource Systems Analysis

Introduction

The objective of many instream flow studies is to compare various water management schemes. These schemes may include both structural and nonstructural considerations. Structural considerations include the size and locations of reservoirs and diversions. Nonstructural considerations comprise the rules for the operation of the reservoir or the diversion. Usually the analysis of the water resource system will be done by the sponsoring agency or group and the streamflows for the various schemes will be made available by the sponsor. The instream flow analyst will (or at least should) be involved in the selection of some of the alternatives. The instream flow work then proceeds through the various time series analyses using the sponsor's streamflow, or management, alternatives, and there is no need for the instream flow analyst to do any water resource systems analysis.

Occasionally, the need for the instream flow analyst to do an analysis of the water resource system does arise. Usually, this is due to the sponsor refusing to study viable alternatives or having limited ability to do a water resource systems analysis. The programs in this chapter are relatively simple water resource systems models that can be used for the analysis in many water resource systems with which the instream flow analyst comes into contact, because most systems are relatively simple. For more complex systems, the analyst should consider using the programs available from the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers, as well as programs available from other groups.

There are three major programs in this chapter that actually do the water resource systems analysis: QABSDY, QABSMN, and RESYLD. The other programs either assist in building input files, analyzing the results of the systems analysis, or reformatting the results of the water resource systems analysis so that they may be used as input to the other TSLIB programs.

The QABSDY and QABSMN programs are available to analyze the situation shown in Fig. 5.1. The idea is that the flow at a downstream control point (Q_O) is related to the flow at an upstream control point (Q_I) by the equation

$$Q_O = Q_I - D,$$

where D is an abstraction (diversion) from the river. The QABSDY program uses average daily flows and the QABSMN uses average monthly flows. An example of the use of the QABSDY program would be the analysis of the effect of a small hydroelectric project on instream flow values. It is assumed that the project does not cause rapid changes in streamflow by operating in peaking mode. A peaking mode project would have to be analyzed using techniques not presented in this manual.

Typically, a small hydroelectric project diverts flow from a river, generates energy, and then returns the water to the river downstream. Often the distance between the diversion point and the return flow point is relatively short with negligible travel time and inflow. In such cases, the situation is as shown in Fig. 5.1 and the management model is

$$D = 0 \quad \text{if} \quad Q_I < QMIN + QTMIN$$

$$D = Q_I - QMIN \quad \text{if} \quad QT > Q_I > QMIN + QTMIN$$

$$D = QT \quad \text{if} \quad Q_I > QMIN + QT,$$

where

Q_I = the streamflow without a diversion,

D = the diversion,

QT = the desired flow through the turbine (or target flow),

QTMIN = the minimum flow that can be used by the turbine, and

QMIN = the minimum flow allowable in the river at any time a diversion occurs.

The power developed by a given project is calculated by the equation:

$$P = e\,\gamma_w\,(D)\,H$$

where

P = the power,

H = the head on the turbine,

γ_w = the unit weight of water,

D = the diversion (hence, flow through the turbine), and

e = the efficiency of the system.

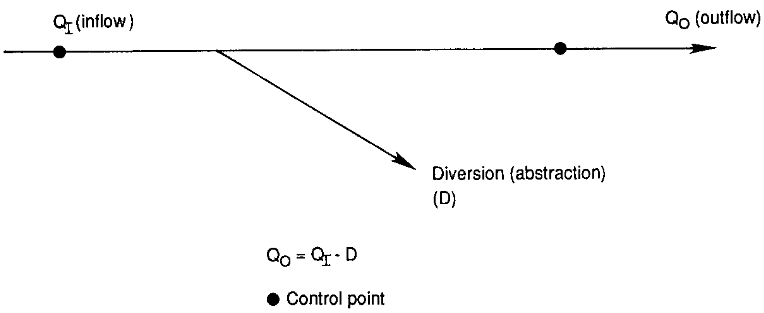


Fig. 5.1. A simple diversion from a stream.

For any system, the efficiency is a function of flow through the turbine and is highest at the design flow for the turbine. Also, any turbine system will have a minimum flow through the turbine below which damage can occur to the turbine.

Daily values of streamflow are used to operate the system using the QABSDY program. After the analysis using the QABSDY program, then the HABTD program (Chapter 6) could be run to obtain the daily values of habitats. The HABTD program also transforms the daily habitats to monthly habitats. The analysis of the monthly habitats then proceeds in the usual manner (Chapter 8). When doing the water resource systems analysis using the QABSDY program, keep in mind how you intend to transform the daily habitats to monthly habitats using one of the methods in HABTD:

- the average daily habitat for a specified month,
- the minimum daily habitat during a specified month,
- the minimum daily habitat for a specified number of consecutive days during the month, and
- the median habitat value for the month.

The use of a minimum *N*-days assumes that fish can be crowded for short periods and cannot fill all the habitat during relatively short periods of excess habitat.

The assumption is made in the analysis that the minimum flows for the project can be specified for each month as the minimum flow during the specified month. The instream flow requirement can be specified for any period desired (i.e., weekly, monthly, a rule curve, etc.). Data for the North Fork of the Snoqualmie River near Snoqualmie Falls, Washington, are used for illustration. The physical habitat-versus-streamflow relation was shown in Chapter 1 of this manual. Only the time series for the adult rainbow trout is presented here.

For this illustration, a flow of 100 cfs was used as the minimum value (QMIN) of the instream flow when a diversion occurs. The minimum diversion (QTMIN) was assumed to be 10 cfs, and the desired diversion (QT) was assumed to be 75 cfs. (Normally, a variable instream flow requirement would be specified.)

The period of records used was for 41 water years (1930–49 and 1962–82). The steps followed were

1. Generate a daily time series of diversions and instream flow using the operation logic and values specified here.
2. Develop a time series of daily habitat values using the streamflow for the cases of with and without the diversion. The daily habitat time series was then converted to a monthly habitat index using the minimum of any 10 consecutive days during the month. The equation is

$$HA(j) = \frac{1}{10}\left[\min\left(\sum_{i=1}^{10} HAD\,(j,i)\right)\right],$$

where

HAD = a daily habitat, and

HA = the habitat index for the month *j*.

Anyone doing a habitat analysis could select other indices as well as other time periods for the index.

A comparison of the preproject and postproject duration curves for the streamflow with all months is given in Fig. 5.2. Figure 5.3 is a comparison of the preproject and postproject physical habitat for adult rainbow trout. Figure 5.4 is a plot of the diversion. Selected data from the duration curves is given in Table 5.1.

How one uses the information in Figs. 5.2 through 5.4, Table 5.1, and the techniques chosen to produce the figures and table themselves depends on the objective selected for the analysis. However, this is outside the scope of this manual.

The use of the monthly diversion program (QABSMN) is similar to the daily diversion program (QABSDY) described previously.

The third water resource systems analysis program is the RESYLD program. This program is a simple reservoir operations program; the system analyzed is shown in Fig. 5.5. The program operates the system by attempting to meet the following demands:

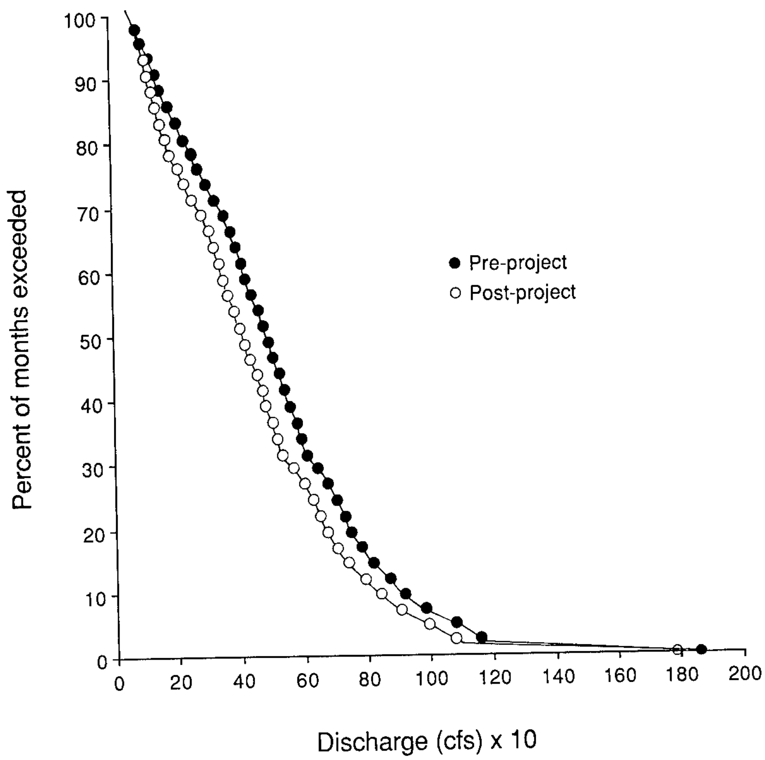


Fig. 5.2. Comparison of pre- and postproject monthly instream flows for a project on the North Fork Snoqualmie River with target diversion of 75 cfs, minimum diversion of 10 cfs, and minimum flow requirement of 100 cfs.

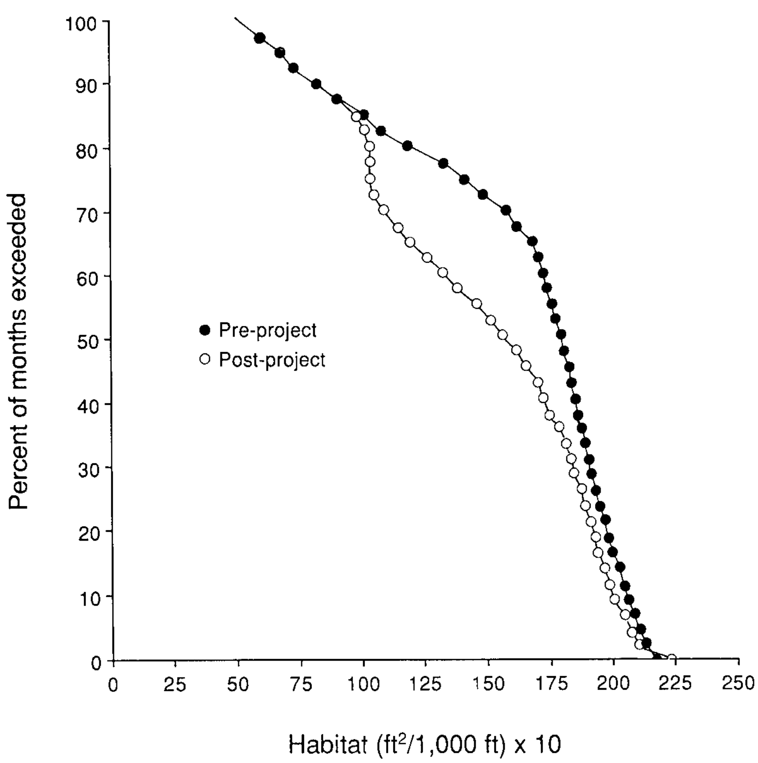


Fig. 5.3. Comparison of pre- and postproject monthly physical habitat for adult rainbow trout for a project on the North Fork Snoqualmie River with target diversion of 75 cfs, minimum diversion of 10 cfs, and minimum instream flow requirement of 100 cfs.

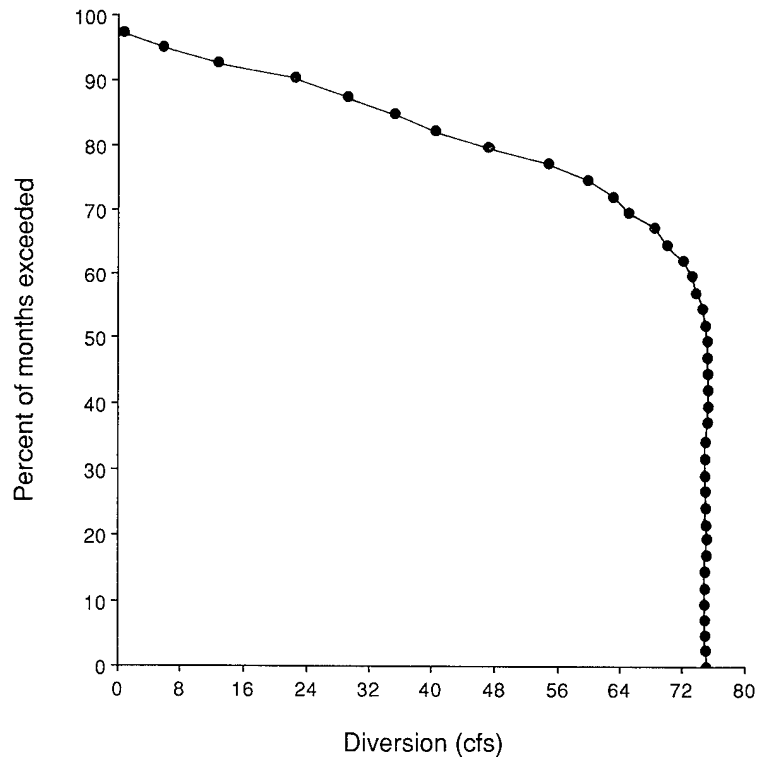


Fig. 5.4. Monthly diversion for a project on the North Fork Snoqualmie River with target diversion of 75 cfs, minimum diversion of 10 cfs, and minimum instream flow requirement of 100 cfs.

1. A diversion from the reservoir (P),
2. A flow used to generate hydropower (Q_P),
3. An instream flow need in the river just downstream of the reservoir (I),
4. A water right diversion at some downstream control point (D), and
5. An instream flow need at the downstream control point (I′).

The three factors not under control of the system operation are the inflow to the reservoir (Q_I), the local inflow downstream from the reservoir (Q_L), and the net evaporation rate from the reservoir surface (E). The actual flow from the reservoir (Q_O), the actual downstream flow ($Q_{O'}$), the actual diversion (P), the actual diversion for water rights downstream (D), and the actual evaporation (E) depend on the criteria used to operate the reservoir and the demands. The actual evaporation (E) is the evaporation rate (e) times the surface area of the reservoir; the surface area depends on the reservoir contents. The equation for the outflow (Q_O) is

$$Q_O = Q_I - \Delta S + P + E$$

and for the downstream control point is

$$Q_{O'} = Q_O + Q_L - D\ Q_L.$$

Table 5.1. *Selected duration data for streamflows, diversions, and adult rainbow trout for the assumed project on the North Fork Snoqualmie River, Washington.*

Statistic	Streamflow (cfs) Without project	Streamflow (cfs) With project	Habitat (ft²/1,000 ft) Without project	Habitat (ft²/1,000 ft) With project	Average diversion (cfs) With project
10% Exceedence	893	818	20,600	20,100	75.0
Average	502	440	16,500	14,900	62.3
Median	474	402	18,200	16,100	75.0
90% Exceedence	137	107	8,500	8,500	22.3

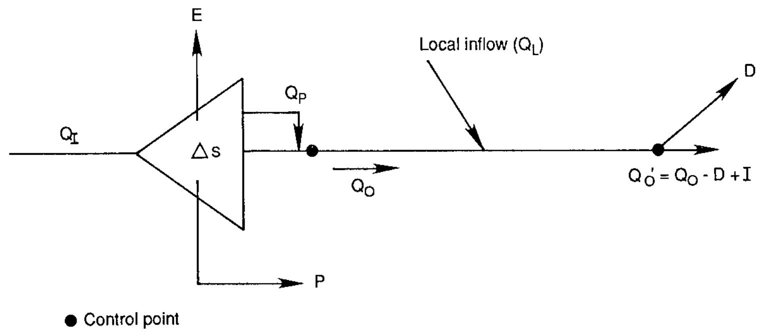


Fig. 5.5 A simple reservoir system.

S = Change in storage
Q_I = Inflow to reservoir
Q_O, Q_O' = Downstream flow
P = Diversion from reservoir
E = Net evaporation
D = Downstream diversion
Q_P = Power generation flow
Q_L = Local inflow

The term ΔS is the change in storage if the reservoir and the terms Q_L are losses from the channel between the control point at the reservoir and the control point downstream.

The operation criteria for the reservoir are part of the logic of the program. There are many options in the program.

The reservoir is considered to be divided into a number of zones as shown in Fig. 5.6. The maximum storage cannot be exceeded without risk of structural failure, and the reservoir cannot be drawn down below the bottom of the usable storage (the absolute minimum) by release to the power house or to any diversion. The actual storage may be reduced below the absolute minimum by evaporation.

The buffer storage is a storage level that activates a reduction in releases below the desired level. The program has a number of options on how the reduction occurs; this is explained in the RESYLD program section. The simplest of this is

$$Q_A = Q_T\left(\frac{S - S_A}{S_B - S_A}\right)$$

where

Q_T = the target release to a specific use,

Q_A = the actual release,

S = the water storage in the reservoir,

S_A = the absolute minimum storage, and

S_B = the buffer storage.

The reduction ranges from zero percent when the reservoir contents are larger than S_B to 100% when the storage is down to the absolute minimum.

The RESYLD program is a derivative of the Reservoir Yield Program of the Hydrologic Engineering Center of the U.S. Army Corps of Engineers (HEC 1966). The program has been modified to allow the analysis to investigate instream flow management alternatives.

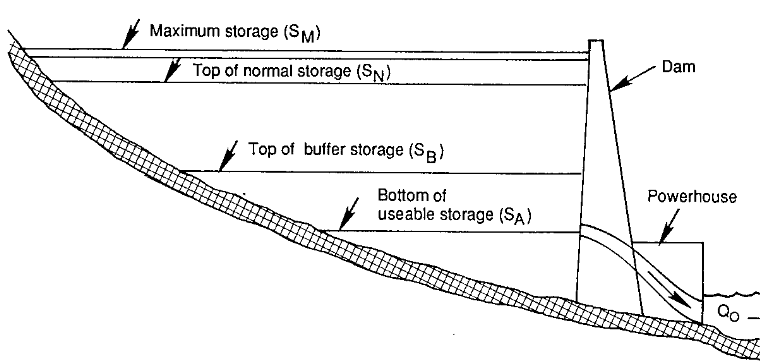


Fig. 5.6. Conceptual division of a reservoir into zones as used in the RESYLD program.

Water Resource Systems Analysis Programs

Program Name	Batch/Procedure Filename	Function	Program Description
QABSDY	**RQABSDY**	Water resource systems analysis	Subtracts a diversion flow by day from a daily streamflow file while leaving a user-specified minimum flow in the main stream. **RQABSDY, ZDQ, ZDQD, ZDQR, ZDQN, ZOUT** **ZDQ** = Daily streamflow file in WATSTORE format, or a free-formatted file with streamflows and dates (input). **ZDQD** = Diversion streamflows in daily flow file format, or a free-formatted file with diversion flows and dates (input). **ZDQR** = Required minimum instream streamflows in daily flow file format, or a free-formatted file with required instream flows and dates (input). **ZDQN** = Daily streamflow file with flows left after the diversion (output). **ZOUT** = QABSDY results, including annual shortages and diversions (output).
QABSMN	**RQABSMN**	Water resource systems analysis	Subtracts a diversion flow by month from a monthly streamflow file while leaving a user-specified minimum flow in the main stream. **RQABSMN, ZMONQ, ZMONQN, ZOUT** **ZMONQ** = Monthly streamflow file in USGS or NWDC format (input). **ZMONQN** = Monthly streamflow file in the same format as the ZMONQ input file, with diversion flows subtracted from the monthly flows (output). **ZOUT** = QABSMN results, including annual shortages and diversions (output).

Program Name	Batch/Procedure Filename	Function	Program Description
RESYLD	**RRESYLD**	Water resource systems analysis	Operates a single reservoir with monthly flows using criteria such as the maximum and minimum flow at the reservoir and downstream, downstream water rights, pipe flow from the reservoir, and power production. **RRESYLD, ZRESIN, ZRES, ZOUT** **ZRESIN** = RESYLD input file created by the RESIN program (input). **ZRES** = RESYLD output file containing pipe and river flows from the reservoir, river flow downstream, reservoir storage, inflow, elevation, evaporation, surface area, unregulated flow downstream, downstream water rights, and power production (output). **ZOUT** = RESYLD results (output).
RESIN	**RRESIN**	RESYLD input file creation	Creates an input file for the RESYLD program with the flows from one or two monthly streamflow files or from user input. **RRESIN, ZRESIN, ZMONQ, ZMONQ2** **ZRESIN** = RESYLD input file (output). **ZMONQ** = Monthly streamflow file in USGS or NWDC format. Reservoir inflows will be calculated from this flow file. The local inflows can also be calculated from this file or entered manually (optional input). **ZMONQ2** = Monthly streamflow file in USGS or NWDC format. Local inflows will be calculated from this flow file if two flow files are used as input (optional input).
CHGMIN	**RCHGMIN**	ZRESIN file modification	Changes the minimum flow values for the river at the dam, the pipe at the dam, and the river at the downstream control point. **RCHGMIN, ZRESIN, ZRESINN** **ZRESIN** = RESYLD input file (input). **ZRESINN** = New RESYLD input file with modified minimum flow values (output).

Program Name	Batch/Procedure Filename	Function	Program Description
RESYI	**RRESYI**	Reservoir yield index computation	Computes the yield index for a reservoir given a RESYLD input file and a monthly time series file with reservoir surface area or storage volume values. **RRESYI, ZRESIN, ZMTS, ZMTSN, ZANTS, ZOUT** **ZRESIN** = RESYLD input file (input). **ZMTS** = Monthly time series file containing reservoir surface areas or storage volumes (input). **ZMTSN** = Monthly time series file containing reservoir yield index values (output). **ZANTS** = Annual time series file containing reservoir yield index values (output). **ZOUT** = RESYI results including area, storage volume, and yield index (output).
RSTOMQ	**RRSTOMQ**	RESYLD output file conversion	Converts the output file (ZRES) from the RESYLD program to a multirecord monthly flow file. **RRSTOMQ, ZRES, ZMONQ** **ZRES** = RESYLD output file (input). **ZMONQ** = Monthly flow file in USGS or NWDC format (output).

CHGMIN Program

Introduction

The CHGMIN program changes the following minimum flow values in the RESYLD input file (ZRESIN): the outflow to the river at the dam, the pipe (diversion) flow at the dam, and the flow in the river at the downstream control point. If the RESYLD input file does not contain minimum flow values for these three items, then they will not be changed.

Running CHGMIN

RCHGMIN, ZRESIN, ZRESINN

ZRESIN = RESYLD input file (input).

ZRESINN = New RESYLD input file with modified minimum flow values (output).

```
DATA TITLE IS—
```

The three title lines and the first period from the input ZRESIN file will be displayed.

```
MINIMUM OUTFLOW TO RIVER IN CFS IS —
 PERIOD           FLOW
```

The periods and the previously entered flows will be displayed.

Example:

Minimum outflow to river in cfs is—

Period	Flow
10	20.00
11	20.00
12	20.00
1	30.00
2	30.00
3	40.00
4	50.00

[more data here]

```
ENTER 0 TO CHANGE MINIMUMS, 1 FOR NO CHANGE:
```

If 0 is entered to change minimums:

```
ENTER NEW MINIMUMS (12):
```

Enter the 12 new values separated by a space, comma, or carriage return.

You will be prompted to change the minimum pipe flow data and the minimum flow at downstream control point data in the same way.

RESIN Program

Introduction

The RESIN program creates an input file for the RESYLD program. Before using the RESIN program, review the RESYLD program documentation for an explanation of the options and variables.

The ZRESIN.DAT file on your sample disk is a sample input file to the RESYLD program that was created by the RESIN program.

Running RESIN

RRESIN, ZRESIN, ZMONQ, ZMONQ2

ZRESIN = RESYLD input file (output).

ZMONQ = Monthly streamflow file in USGS or NWDC format (optional input). (Reservoir inflows will be calculated from this flow file; local inflows can also be calculated from this file or entered manually.)

ZMONQ2 = Monthly streamflow file in USGS or NWDC format (optional input). (Local inflows will be calculated from this flow file if two flow files are used as input.)

```
ENTER   1 FOR FULL RESYLD INPUT FILE
        0 FOR RESERVOIR AND LOCAL INFLOWS ONLY
```

The reservoir and local inflow data (lines beginning with QR and QL) are at the bottom of the ZRESIN file. Option 0 creates a file with just these lines. This allows the analysis of the same RESYLD data using different reservoir and local inflows. The original RESYLD input file would be edited and the QR and QL lines replaced with the new QR and QL lines.

```
ENTER   1 TO READ RESERVOIR INFLOWS FROM MONTHLY FLOW FILE
        0 TO ENTER RESERVOIR INFLOWS FROM KEYBOARD:
```

If 1 is entered, the reservoir inflows will be calculated from the first streamflow file (ZMONQ) specified as input.

```
ENTER   1 FOR LOCAL INFLOW FROM A SEPARATE FILE
        0 OTHERWISE
```

If 0 is entered, local inflows will either be calculated from the first streamflow file (ZMONQ) specified as input or entered manually.

If 1 is entered, the local inflows will be calculated from the second streamflow file (ZMONQ2) specified as input.

```
ENTER THREE TITLE LINES FOR THE RESYLD INPUT FILE:
```

Enter three lines of information (up to 80 characters per line) to identify the information.

RESYLD IOC OPTIONS: (See Table 5.1).

```
IOC(1)  - IF RESERVOIR RELEASE IS LESS THAN DOWNSTREAM DEMAND:
        0 = TO SET FLOW EQUAL TO 0.0
        1 = TO SET FLOW TO RESERVOIR INFLOW

 ENTER IOC(1):

 IOC(2)  - TREATMENT OF CONFLICTS BETWEEN PIPE AND RIVER
        0 = PIPE HAS PRIORITY OVER RIVER
        1 = PIPE AND RIVER HAVE EQUAL PRIORITY
        2 = RIVER HAS PRIORITY OVER PIPE
        3 = USE A REDUCTION LIMITED BY AN ABSOLUTE
            MINIMUM FOR PIPE AND/OR RIVER THAT WILL BE
            DELIVERED IF AT ALL POSSIBLE, EQUAL PRIORITY
            OTHERWISE
        4 = LIMIT RELEASE TO RIVER IF STORAGE IS LESS THAN
            A GIVEN MINIMUM. PIPE HAS PRIORITY
        5 = RIVER AND PIPE HAVE ABSOLUTE LIMIT OF FLOWS
            AND FLOW FOR RIVER. OTHERWISE EQUAL PRIORITY

 ENTER IOC(2):

 IOC(3)  - USE OF STORAGE ANALYSIS
        0 = USE BUFFER STORAGE ANALYSIS TO REDUCE RELEASE
        1 = DO NOT USE BUFFER STORAGE ANALYSIS

 ENTER IOC(3):

 IOC(4)  - TREATMENT OF SHORTAGE IN DOWNSTREAM BUFFER ZONE
        0 = USE FLOW MINUS EVAPORATION PLUS WATER FROM BUFFER
            ZONE
        1 = USE FLOW PLUS WATER FROM BUFFER ZONE

 ENTER IOC(4):

 IOC(5)  - SELECTION OF INITIAL RESERVOIR CONTENTS
            FOR MORE THAN ONE GROUP OF YEARS
        0 = USE VALUE GIVEN FOR FIRST GROUP OF YEARS
        1 = USE RESERVOIR CONTENTS FROM END OF PREVIOUS GROUP
            OF YEARS

ENTER IOC(5):

ENTER ID NUMBER FOR PROJECT (10 CHAR MAX):
```

This ID number is used as a reference for the site, run, or whatever the user chooses.

If IOC(2) is 3 or 4:

```
ENTER ABSOLUTE MINIMUM RIVER RELEASE:
ENTER MINIMUM STORAGE FOR RIVER RELEASE:
ENTER ABSOLUTE MINIMUM DIVERSION RELEASE:
ENTER MINIMUM STORAGE FOR DIVERSION RELEASE:
```

If IOC(2) is 5:

```
ENTER ABSOLUTE MINIMUM RIVER RELEASE:
ENTER MINIMUM STORAGE FOR RIVER AND DIVERSION RELEASE:
ENTER ABSOLUTE MINIMUM DIVERSION RELEASE:
ENTER THE NUMBER OF TIME PERIODS THE MINIMUM FLOW
MAY BE RELEASED:
ENTER FLOW IF MINIMUM RIVER RELEASE HAS BEEN USED
FOR TOO MANY TIME PERIODS:
ENTER THE NUMBER OF YEARS AND THE STARTING YEAR:
```

Enter the number of years to be analyzed and the first year to analyze.

```
ENTER 0 TO USE MONTHS FOR TIME PERIODS, OR ENTER THE NUMBER
OF TIME PERIODS FOR EACH YEAR (MAXIMUM 15):
```

The year can be divided into up to 15 periods of equal or unequal length; the usual application is in months.

```
ENTER THE STARTING TIME PERIOD (10 = OCTOBER, ETC.):
```

For example, if the first month on the input monthly streamflow file(s) is October (streamflow files are usually in water years) and you are using monthly periods, you would enter 10 here. Another example, if you were using six periods of 2 months each and your flow data starts with October, then you would enter 5 because the fifth period starts with October.

If months are not being used as periods, then you will be prompted to:

```
ENTER THE NUMBER OF DAYS IN EACH TIME PERIOD, OR
0 TO ENTER A DIFFERENT NUMBER OF DAYS FOR EACH
TIME PERIOD:

READING RESERVOIR FLOW VALUES
READING LOCAL FLOW VALUES
```

This message will only be displayed if reservoir and local inflow values are being read from monthly streamflow files. If there are errors in the file(s), the program will print out a message to identify the file that contains the error.

```
ENTER THE NUMBER OF POINTS IN THE RESERVOIR STORAGE
TABLE (MAX 40):
```

This is the storage-versus-area and storage-versus-elevation table for the reservoir.

```
ENTER [—] RESERVOIR STORAGE VALUES IN ACRE-FEET:
```

The blank will contain the number of points entered in the previous step. Enter the reservoir storage values (in acre-feet) corresponding to the surface areas and elevations for each point. These values must increase continuously.

```
ENTER THE [—] RESERVOIR SURFACE AREAS IN ACRES:
```

Enter the reservoir area in acres for each storage value entered in the previous step.

```
ENTER 1 TO USE WATER SURFACE ELEVATIONS, OR 0 IF WATER
SURFACE ELEVATIONS ARE NOT TO BE USED (POWER PRODUCTION IS
NOT BEING CONSIDERED).
```

If 1 is entered:

```
ENTER [—] RESERVOIR WATER SURFACE ELEVATIONS (IN FEET):
```

Enter the reservoir water surface elevations (in feet) for each storage value entered.

> RESYLD WILL ALLOW YOU TO RUN THROUGH COMPUTATIONS FOR UP TO FOUR DIFFERENT GROUPS OF YEARS FROM THE FLOWS ON THE DATA SET. THE GROUPS OF YEARS MUST BE CONSECUTIVE.

```
ENTER THE NUMBER OF GROUPS OF YEARS:
```

For example, if 3 is entered, you will be prompted to

```
ENTER NUMBER OF YEARS AND STARTING YEAR FOR THE
3 GROUPS OF YEARS:
```

RESYLD will process the flow data for each group of years specified. The program can start with any year in the data set and use any number of years less than or equal to the remainder in the data set.

```
ENTER   1 FOR FLOW REQUIREMENTS IN ACRE-FEET PER PERIOD
        0 FOR FLOW REQUIREMENTS IN CUBIC FEET PER SECOND
```

All flow requirements (i.e., minimum diversion flows, maximum instream flows, etc.) must use the same unit, either acre-feet per period or cubic feet per second.

```
ENTER THE NUMBER OF COMPUTATION ITERATIONS (USUALLY 2):
```

Enter the number of complete computations desired for each period for successive approximations of power, evaporation, and reservoir quality. Usually "2" is entered.

```
ENTER   1 TO PRINT YEARLY CALCULATIONS
        0 OTHERWISE:
```

Option 0 lists averages and other statistics for the entire run; option 1 lists statistics by year.

```
ENTER THE INITIAL STORAGE (IN ACRE-FEET) OF THE RESERVOIR:
```

Enter the reservoir storage (in acre-feet) at the start of the analysis.

```
ENTER CONVERSION FACTOR FOR RESERVOIR INFLOWS

IF THE RESERVOIR AND LOCAL INFLOWS ARE IN CFS,
ENTER A POSITIVE CONVERSION FACTOR OR 0 FOR NO CONVERSION;

IF THE RESERVOIR AND LOCAL INFLOWS ARE IN ACRE-FEET,
ENTER A NEGATIVE CONVERSION FACTOR OR -1 FOR NO CONVERSION:
```

> FOR THE FOLLOWING PROMPTS, IF –2 IS SELECTED, YOU WILL BE PROMPTED IMMEDIATELY FOR THE DATA FOR THE FIRST YEAR. YOU WILL BE PROMPTED LATER TO ENTER THE VALUES FOR ADDITIONAL YEARS.

```
ENTER MINIMUM REQUIRED FLOW TO RIVER (INSTREAM FLOW) AT DAM:
  -1 TO ENTER RIVER FLOW VALUES FOR EACH TIME PERIOD
  -2 TO ENTER RIVER FLOW VALUES FOR EACH TIME PERIOD EACH YEAR:
```

This option allows you to specify a minimum instream flow for the stream below the dam for each period (usually a month).

If –1 or –2 is entered:

```
ENTER THE [--] MINIMUM FLOW VALUES:
```

The blank will contain the number of periods for each year specified in a previous prompt. If –2 was selected, enter the minimum flow values for the first year. You will later be prompted to enter the values for additional years.

> Note: This type of prompting will be done whenever –1 or –2 are selected for the following prompts.

```
ENTER MINIMUM REQUIRED DIVERSION (PIPE) FLOW AT DAM
  -1 TO ENTER MINIMUM DIVERSION FLOW VALUES FOR EACH TIME
     PERIOD
  -2 TO ENTER DIVERSION FLOW VALUES FOR EACH TIME PERIOD,
     EACH YEAR:
```

This is the minimum flow to divert (abstract) from the dam (that flow necessary for municipal, irrigation, or other purposes).

```
ENTER CHANNEL CAPACITY AT DAM
  -1 TO ENTER CHANNEL CAPACITIES FOR EACH TIME PERIOD
  -2 TO ENTER CHANNEL CAPACITIES FOR EACH TIME PERIOD EACH
     YEAR:
```

This is the maximum permissible flow to the channel without causing flood damages.

```
ENTER MINIMUM REQUIRED FLOW AT DOWNSTREAM CONTROL POINT
  -1 TO ENTER MINIMUM FLOW VALUES FOR EACH TIME PERIOD
  -2 TO ENTER FLOW VALUES FOR EACH TIME PERIOD, EACH YEAR:
```

This is the minimum permissible flow at a downstream point considering a local inflow below the reservoir and some downstream control point (local flow loss will be considered later). Water rights should *not* be considered in this minimum flow value. This value will be specified later.

```
ENTER THE MAXIMUM PERMISSIBLE FLOW AT DOWNSTREAM CONTROL POINT
  -1 TO ENTER MAXIMUM FLOW FOR EACH TIME PERIOD
  -2 TO ENTER FLOW VALUES FOR EACH TIME PERIOD, EACH YEAR:
```

This is the maximum permissible flow at a downstream point. This is usually the channel capacity at that point.

```
ENTER MINIMUM REQUIRED FLOW FOR WATER RIGHTS DOWNSTREAM OF THE
CONTROL
  -1 TO ENTER WATER RIGHT FLOW VALUES FOR EACH TIME PERIOD
  -2 TO ENTER WATER RIGHT FLOW FOR EACH TIME PERIOD, EACH YEAR:
```

This is the minimum permissible flow downstream from the control point for water rights.

```
ENTER  1 IF WATER QUALITY ANALYSIS IS TO BE DONE
       0 OTHERWISE:
```

If 1 is entered:

```
ENTER EFFLUENT (IN TONS PER DAY) BETWEEN RESERVOIR
AND DOWNSTREAM POINT FOR ALL TIME PERIODS,
  -1 TO ENTER EFFLUENT FOR EACH TIME PERIOD, OR
  -2 TO ENTER EFFLUENT FOR EACH TIME PERIOD, EACH YEAR:
```

Enter the effluent (in tons per day) between the reservoir and some downstream control point.

```
ENTER MAXIMUM PERMISSIBLE CONCENTRATION (IN PPM OR
DEGREES OF TEMPERATURE) OF WATER QUALITY FACTOR
AT DOWNSTREAM POINT FOR ALL TIME PERIODS,
  -1 TO ENTER W.Q. VALUES FOR EACH TIME PERIOD, OR
  -2 TO ENTER W.Q. VALUES FOR EACH TIME PERIOD, EACH YEAR:
ENTER INITIAL WATER QUALITY OF RESERVOIR:
```

Enter the initial water quality of the reservoir (in parts per million or degrees of temperature).

```
ENTER THE NUMBER OF WATER QUALITY-VERSUS-RESERVOIR
INFLOW PAIRS (MAX 10):
```

Reservoir inflow must increase continuously.

```
ENTER NUMBER OF WATER QUALITY-VERSUS-LOCAL INFLOW
PAIRS (MAX 10):
```

Local inflow must increase continuously.

```
ENTER MAXIMUM RESERVOIR STORAGE FOR ALL TIME PERIODS,
  -1 TO ENTER MAXIMUM STORAGE VALUES FOR EACH TIME PERIOD, OR
  -2 TO ENTER MAXIMUM STORAGE FOR EACH TIME PERIOD, EACH YEAR:
```

This is the maximum permissible reservoir storage (in acre-feet) for the whole period or for each period.

```
ENTER MINIMUM RESERVOIR STORAGE FOR ALL TIME PERIODS
  -1 TO ENTER MINIMUM STORAGE FOR EACH TIME PERIOD
  -2 TO ENTER MINIMUM STORAGE VALUES FOR EACH TIME PERIOD,
     EACH YEAR:
```

This is the minimum permissible reservoir storage.

```
ENTER MINIMUM STORAGE FROM BUFFER ZONE FOR ALL TIME PERIODS,
  -1 TO ENTER MINIMUM STORAGE FOR EACH TIME PERIOD, OR
  -2 TO ENTER MINIMUM STORAGE FOR EACH TIME PERIOD, EACH YEAR:
```

Specify a storage level greater than or equal to the minimum permissible reservoir storage at which shortage is initiated.

```
ENTER  1 IF HYDROPOWER IS PART OF THE ANALYSIS
       0 OTHERWISE:
```

If 1 is entered:

```
ENTER MINIMUM POWER PRODUCTION FOR ALL TIME PERIODS,
  -1 TO ENTER MINIMUM POWER FOR EACH TIME PERIOD, OR
  -2 TO ENTER MINIMUM POWER FOR EACH TIME PERIOD, EACH YEAR:
```

Specify a minimum power requirement per period (in thousands of kilowatts per hour).

```
ENTER INSTALLED POWER CAPACITY IN KILOWATTS PER HOUR:

ENTER THE POWER PLANT EFFICIENCY, 0 TO USE STANDARD
VALUE OF .86, -1 TO ENTER POWER-VERSUS-EFFICIENCY TABLE:
```

If –1 is selected, plant efficiency values are expressed as a ratio less than 1 corresponding to reservoir elevations.

```
ENTER THE AVERAGE TAILWATER ELEVATION IN FEET:

ENTER OUTLET FLOW CAPACITY OR  -1 TO USE A FLOW
CAPACITY-VERSUS-STORAGE TABLE:
```

Enter an outlet flow capacity in cfs, or up to 10 outlet capacities (in cfs) versus reservoir storages (in acre-feet) may be specified. These values must increase continuously.

```
ENTER AN EVAPORATION VALUE FOR ALL TIME PERIODS,
  -1 TO ENTER EVAPORATION VALUES FOR EACH TIME PERIOD, OR
  -2 TO ENTER EVAPORATION FOR EACH TIME PERIOD, EACH YEAR:
```

Enter a reservoir evaporation (net change to project conditions) in inches per year or specify to enter a reservoir evaporation value for each period.

```
ENTER FLOW LOSS BEFORE DOWNSTREAM CONTROL POINT FOR ALL TIME PERIODS,
  -1 TO ENTER FLOW LOSS FOR EACH TIME PERIOD, OR
  -2 TO ENTER FLOW LOSS FOR EACH TIME PERIOD, EACH YEAR:
```

Enter a constant channel loss below the reservoir (in cfs), or specify to enter a constant channel loss for each period.

```
ENTER FLOW LOSS AT DOWNSTREAM CONTROL:
```

Enter a channel loss below the reservoir as a ratio of flow remaining after any constant loss is subtracted.

```
ENTER PENSTOCK LOSS COEFFICIENT:
```

This prompt will only appear if hydropower is being analyzed.

```
ENTER FULL RESERVOIR STORAGE:
```

This is the full pool reservoir capacity (in acre-feet).

```
ENTER MAXIMUM PERMISSIBLE POWER GENERATION RATE:
```

This prompt will appear only if hydropower is being analyzed.

```
OBTAIN RESERVOIR AND LOCAL INFLOWS OR CONVERT MONTHLY
FLOW FILE TO RESERVOIR AND LOCAL INFLOWS
```

At this point you will either enter the reservoir and local inflows manually, or they will be calculated, depending on whether monthly streamflow files were specified as input.

If one monthly flow file was used as input, the reservoir inflows will be calculated from this flow file. The local inflows can either be calculated from the flow file or entered manually. If two streamflow files were used as input, reservoir inflows will be calculated from the first monthly flow file and local inflow will be calculated from the second monthly flow file.

If ZMONQ was specified as input:

```
ENTER MULTIPLIER TO TRANSFORM MONTHLY FLOWS TO RESERVOIR INFLOWS:

ENTER 6 CHAR STATION NUMBER FOR RESERVOIR INFLOWS:
```

This number is on QR lines.

If 0 was entered for third prompt in program:

This prompt specified that local inflows would either be calculated from the first streamflow file (ZMONQ) specified as input or entered manually.

```
ENTER  0 FOR DIRECT ENTRY OF LOCAL INFLOWS
       1 FOR LOCAL INFLOWS AS A MULTIPLIER * MONTHLY FLOWS:
```

If 1 is selected:

```
ENTER MULTIPLIER FOR LOCAL INFLOWS:

ENTER 6 CHAR STATION NUMBER FOR LOCAL INFLOWS:
```

This number is on QL lines.

> Note: If –2 (Enter [——] for each time period, each year) was entered for any prompt in the program, you will now be prompted to enter the values for each time period for each year.

RESYI Program

Introduction

The RESYI program is included in this chapter because one of the important fisheries tradeoffs in systems management is the production of fish in the reservoir versus the production of fish in the river. The RESYI program gives some idea of the variation in fishery production in the reservoir as a result of water management activities.

The RESYI program uses a productivity index based on an equation for reservoir presented in Youngs and Heimbuch (1982). The equation is

$$\text{Yield} = 259.82\ A^{1.56}\ d^{-0.54}\ (\text{TDS})^{0.34}$$

where

A is the surface area of the reservoir (in km^2),
d is the mean depth (in m), and
TDS is the total dissolved solids (in mg/L).

The yield is in kilograms. The mean depth is calculated using the generic equation

$$d = \frac{V}{A},$$

where

A is the surface area of the reservoir, and
V is volume in km^2 – m.

Replacing the depth with this equation gives

$$\text{Yield} = 260\ A^{1.56}\ V^{-0.54}\ (\text{TDS})^{0.34}.$$

The assumption made in using the equation to compare water management alternatives is that the change in yield is a similar function of the same terms. An additional assumption is that the total dissolved solids (TDS) does not change because of a change in water management. The average TDS used to develop the equation was 121 mg/L, which is used to eliminate the TDS term. The result is

$$\text{Yield} = 1{,}328\ A^{1.56}\ V^{-0.54}.$$

The program actually works with traditional units (volume in acre-feet and surface area in acres). With these units the equation is

$$\text{Yield} = 9.14\ A^{1.56}\ V^{-0.54}.$$

The yield is still in kilograms. The yield calculated by the RESYI program should only be considered as an index to the production from the reservoir. It is the variation that is important in an instream flow study.

The equation could be expressed as

$$\text{Yield} = x\ A^{y}\ V^{z}$$

with the user supplying the values for x, y, and z. This option is available in the program.

Running RESYI

RRESYI, ZRESIN, ZMTS, ZMTSN, ZANTS, ZOUT

ZRESIN = RESYLD input file (input).

ZMTS = Monthly time series file containing reservoir surface areas or storage volumes (input).

ZMTSN = Monthly time series file containing reservoir yield index values (output).

ZANTS = Annual time series file containing reservoir yield index values (output).

ZOUT = RESYI results including area, storage volume, and yield index (output).

Figure 5.7 contains sample output from the RESYI program. The ZRESIN.DAT and SVR30.DAT files on your sample disk were used as input.

```
ENTER TWO LINE TITLE FOR ANNUAL TIME SERIES FILE:
```

This output file (ZANTS) is an annual time series file containing reservoir yield index values.

```
ENTER THE INDEX FOR THE FIRST MONTH ON THE MONTHLY
TIME SERIES FILE (JAN. = 1, FEB. = 2, ETC.):
```

This labels the months in the input monthly time series file (ZMTS). If the first month is October, you would enter 10 here.

```
THE YIELD INDEX WILL BE CALCULATED USING THE EQUATION:
            A * (AREA ** B) * (STORAGE ** C)

ENTER A, B, AND C OR THREE 0'S TO USE DEFAULT VALUES
A = 9.14  B = 1.56  C = -0.54

ENTER  0 IF MONTHLY TIME SERIES FILE CONTAINS SURFACE
         AREA, OR
       1 IF MONTHLY TIME SERIES FILE CONTAINS STORAGE
         VOLUME
```

The input monthly time series file may contain surface areas or storage volumes. The SVR30.DAT file used to generate the output in Fig. 5.7 contained storage volumes.

```
ENTER  1 TO PLOT MINIMUM ANNUAL YIELD INDICES
       0 OTHERWISE:
```

This is a tabloid plot that will appear on the screen and be written to the ZOUT file.

```
DATE  - 90/07/24.        MELVERN RESERVOIR ROUTING DATA SET                                  PROGRAM - RESYI
TIME  - 14.48.40.        DATA FROM CORPS OF ENGINEERS                                          PAGE -    1


INPUT FILE:

     MELVERN RESERVOIR ROUTING DATA SET
      DATA FROM CORPS OF ENGINEERS
       MIN RIVER = 20, PIPE VARIABLE
 IOC        01010000000000000000                         STATION NUMBER: QR911000


       YIELD INDEX BASED ON THE EQUATION:

           9.14 * (AREA **  1.56) * (STORAGE ** -0.54)

 SURFACE AREA    STORAGE VOLUME       YIELD INDEX

       20.80            58.40              115.68
       52.00           269.70              211.46
       71.10           608.90              221.93
      225.20          1373.00              864.19
      597.40          3787.00             2288.97
     1035.00          8688.00             3445.37
     1511.00         16300.00             4426.06
     1985.00         26722.00             5187.32
     2704.00         40551.00             6707.42
     3744.00         59843.00             9031.56
     4723.00         85384.00            10709.83
     5696.00        116599.00            12123.27
     6935.00        154393.00            14161.83
     8404.00        200313.00            16604.32
    10165.00        255775.00            19578.98
    11667.00        299260.00            22301.60
    14442.00        349110.00            28626.28
    17436.00        472668.00            32609.38
    20806.00        587216.00            38209.31
    22061.00        630072.00            40302.36
```

The computed monthly and annual yield index values will also be listed in the file. These are the same values that are written to the ZMTSN and ZANTS output files from RESYI.

Fig. 5.7. Sample output from RESYI program.

RESYLD Program

Introduction

The purpose of the RESYLD program is to analyze the yield of water from a reservoir (or a reach of stream). The program operates a single reservoir with monthly flows using criteria such as maximum and minimum flows at the reservoir and downstream, downstream water rights, pipe flow from the reservoir, and power production.

The RESYLD program was originally the RESservoir YieLD program (computer program 23-J2-L245) developed by L. R. Beard of the Hydrologic Engineering Center of the U.S. Army Corps of Engineers (650 Capitol Mall, Sacramento, California). The version of the RESYLD program contained in the TSLIB programs has been modified by the Aquatic Systems Modeling Section at the National Ecology and Research Center to allow the analysis of instream flow management alternatives.

The RESYLD program performs any number of multipurpose routings under identical conditions for a single reservoir with optional delivery to a pipe (diversion) or river, or both, and with maximum and minimum flow controls at the reservoir and, if desired, at one downstream control point. Power generation at the reservoir and quality control at the downstream control point are optional. The year is divided into any number of periods (maximum of 15) of equal or unequal length. Maximum and minimum permissible storages (and all other quantities) can be specified as uniform or varied, with similar or dissimilar patterns each year. An optional minimum storage above the absolute minimum can be specified at which shortages in withdrawals from storages are declared, increasing linearly to 100% at the absolute minimum storage.

The RESYLD program follows closely the procedures commonly used in hand computation. Where a direct solution is not possible, as in evaporation and power computation, successive approximations are made. The first approximation, based on reservoir stage at the beginning of each period, is used to establish an approximate average stage for the period; the next approximations of evaporation and power are based on this average stage. Outlet capacity is approximated once only on the basis of reservoir stage at the start of each period. No delay or routing of outflows to the downstream control point is made. Provision is made for an optional buffer zone at the bottom of the conservation pool.

The reservoir routing is made by first searching for the largest of the minimum flow requirements for all purposes and the smallest of the maximum permissible flows. The former will control if there is no conflict; the latter will control if there is conflict. These controls are overridden by flows necessary to empty or fill the conservation pool.

Absolute control is exercised by full reservoir and empty reservoir limitations. If storage at the start of a period is within the bottom buffer zone and all IOC options are zero, then the release from the reservoir (over and above inflow minus evaporation) is reduced by the proportion of empty space in the buffer zone. Releases are first assigned to the pipe and the remainder goes to the river. These controls can be changed by the use of the IOC options (Table 5.2) added by the Aquatic Systems Modeling Section.

Power is generated from release to the river up to plant capacity. Power generation and release required for power are based on the following equation:

$$P = 0.08464eQH,$$

where

P = power (in kilowatts),

e = efficiency as a ratio <1,

Q = flow (in cfs), and

H = head (in feet) on the power plant.

If an efficiency factor is not given (either as a constant or tabulated against reservoir level), a standard value of 0.86 is used. Head on the power plant is the reservoir stage minus a constant tailwater elevation minus an optional hydraulic loss either expressed in feet or computed as follows:

$$H_L = CQ^2/64.4$$

where

H_L = hydraulic loss (in feet),

C = input constant to be specified by the user, and

Q = flow (in cfs).

This head loss is computed only approximately for power release requirements, assuming that outflow required for minimum power generation is met, regardless of other requirements or reservoir storage limitations. Final power generation quantities are based on losses computed from actual river releases and are limited by full generation capacity for the period with a load factor of 1.

Table 5.2. *Options in the RESYLD Program.*

Option	Action
IOC(1)	Determines how reservoir releases are handled to meet downstream demand: One approach is to use the buffer criteria in the program; the second approach is to never release less water than the reservoir inflow when the demand is not met. 0 = Use buffer criteria. 1 = Set release to inflow when demand is not met.
IOC(2)	Determines the way a shortage is handled. 0 = When the release is less than the demand, reduce the instream flow release first without reducing the diversion, until no water is released for instream purposes. 1 = Reduce the diversion and instream flow in equal proportion when a shortage occurs. 2 = Reduce the diversion first until no diversion occurs; then reduce the instream flow. 3 = Similar to 2, except for an absolute minimum level for the diversion. 4 = Similar to 0, except that the instream release is reduced to a specified minimum when the reservoir contents are reduced below some specified minimum storage level. 5 = When the reservoir is reduced to some minimum level, the diversion and instream flows are reduced to a specified ratio. When further reduction is needed, each is reduced proportionately.
IOC(3)	Allows the analyst to turn off the buffer control or releases without needing to change the input file. 0 = Use buffer criteria. 1 = Do not use buffer criteria.
IOC(4)	The evaporation from the reservoir can be charged to the downstream users or to the reservoir owner. 0 = Downstream diversion is reduced by the evaporation when a shortage occurs. 1 = Reservoir diversion is reduced by the evaporation when a shortage occurs.
IOC(5)	When two or more cycles are made through the streamflow data, the initial reservoir contents can be reset to the original data set or to the value at the end of the previous cycle. 0 = Use initial storage given in input file. 1 = Use final storage from previous cycle as intended.

Water quality computations are based on the assumption of complete mixing in the reservoir and river. Provision is made only for maximum temperature of concentration control—not for minimum. This provision could be added easily, however. Water rights are assumed to be limited to reservoir inflow minus channel losses plus local inflow. Releases for quality control are limited by outlet and channel capacities and are curtailed when reservoir concentration exceeds permissible concentration downstream.

Shortage indexes are computed separately for releases to pipeline; for releases to river; for power; and for flow at a downstream control point (exclusive of water rights). The shortage index is the sum of squares of annual shortages expressed as a ratio to annual requirement, divided by the number of years of record to give an annual average, then multiplied by 100 to give a percentage.

Input to the RESYLD program is an input file created by the RESIN program. All storages are in acre-feet and inflows can be in any units, but all inflows must be expressed in the same units of volume or rate of flow. Required flows can be expressed in cfs or acre-feet; however, all flows and required flows are printed out in cfs.

Features of the program that are not required for a problem are usually automatically omitted when the variables pertinent to those features are not selected in the RESIN program.

There are two output files from the RESYLD program: ZRES, which contains a monthly status of all the variables (river and pipe flows from the reservoir, river flow downstream, reservoir storage, inflow, elevation, evaporation, surface area, unregulated flow downstream, downstream water rights, and power production). The ZOUT file contains monthly and annual summaries along with pipeline, outlet, downstream, and power shortage indices. All storages and evaporation output are in acre-feet; flows and loss is in cubic feet per second (cfs); and power is in thousands of kilowatts per hour.

Other programs used in conjunction with the RESYLD program are

RESIN — Creates an input file for the RESYLD program.
CHGMIN — Changes the minimum flow values for the river at the dam, the pipe at the dam, and the river at the downstream control point in the RESYLD input file.
RESYI — Computes the yield index for a reservoir from a RESYLD input and a monthly time series file with reservoir surface area or storage volume values.
RSTOMQ — Converts the ZRES file (output from RESYLD) to a multirecord monthly flow file. This conversion enables the information from RESYLD to be further analyzed using the programs presented in Chapters 6–9.

Figure 5.8 shows the flow of information through the RESYLD program.

Running RESYLD

RRESYLD, ZRESIN, ZRES, ZOUT

ZRESIN = RESYLD input file created by the RESIN program (input).

ZRES = RESYLD output file containing pipe and river flows from the reservoir, river flow downstream, reservoir storage, inflow, elevation, evaporation, surface area, unregulated flow downstream, downstream water rights, and power production (output).

ZOUT = RESYLD results (output).

Figure 5.9 is a sample ZRES output file from RESYLD; Fig. 5.10 is a sample ZOUT file. Table 5.3 contains definitions of the variables in the RESYLD output.

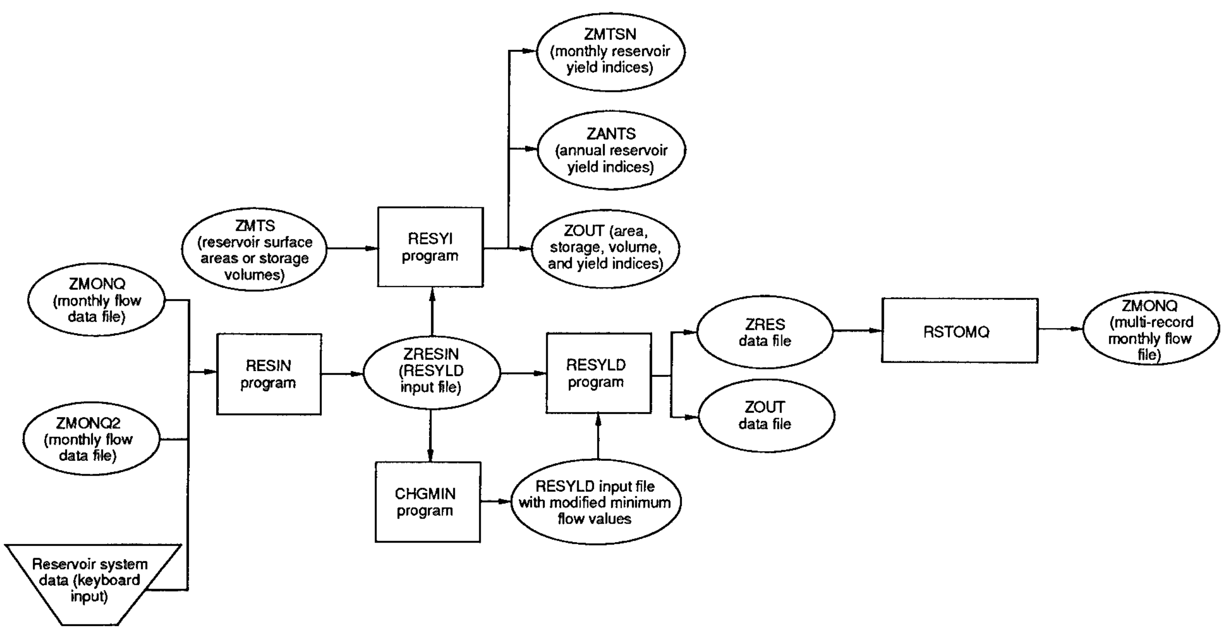


Fig. 5.8. Flow of information through the RESYLD program.

```
   MELVERN RESERVOIR ROUTING DATA SET
      DATA FROM CORPS OF ENGINEERS
       MIN RIVER = 20, PIPE VARIABLE
90/06/25.          10.47.50.                 STATION NUMBER: QR911000
YEAR      QPIPE   QRIVER        QD    STORB   INFLOW    D/SNAT       ELEV      EVAPA       AREA   RIGHTS    POWER
1940 10   30.00    20.00     20.00  158356.     0.00      0.00    1036.52    1569.93    7136.06     0.00     0.00
1940 11   30.00    20.00     20.00  153814.     0.00      0.00    1035.91    1566.72    6989.12     0.00     0.00
1940 12   30.00    20.00     20.00  150465.     0.00      0.00    1035.38     274.44    6861.12     0.00     0.00
1940  1   30.00    30.00     30.00  146736.     0.00      0.00    1034.78      39.35    6745.10     0.00     0.00
1940  2   30.00    30.00     30.00  143216.    -0.00      0.00    1034.23     187.74    6626.29     0.00     0.00
1940  3   30.00    40.00     40.00  137708.     0.00      0.00    1033.35    1203.88    6478.30     0.00     0.00
1940  4   30.00    50.00     50.00  131241.     0.00      0.00    1032.32    1706.61    6282.02     0.00     0.00
1940  5   30.00    50.00     50.00  126231.     0.00      0.00    1031.53      91.41    6093.88     0.00     0.00
1940  6   30.00    50.71     51.00  120898.     7.28      7.57    1030.68     962.70    5924.35     1.00     0.00
1940  7   30.00    50.00     54.58  119318.   114.62    119.21    1030.43    3709.37    5811.04     1.00     0.00
1940  8   30.00    20.48     21.00  114873.    12.96     13.48    1029.67    2137.34    5712.28     1.00     0.00
1940  9   30.00    20.32     20.33  110922.     0.32      0.33    1028.91     976.60    5580.62     0.33     0.00
```

Fig. 5.9. Sample output (ZRES) from the RESYLD program. This data would be calculated for each year being analyzed.

```
         PROGRAM - RESYLD          DATE - 90/06/25.          TIME - 10.47.50.            PAGE - 1
             MELVERN RESERVOIR ROUTING DATA SET
              DATA FROM CORPS OF ENGINEERS

         PRINCIPLE CONTROL VARIABLES

   NYRS      IYR     NPER     IPER     NDYS    NSTOR    NCYCL     IACFT     NCMP    IPRNT
     39     1940       12       10       -1       21        1         0        2        0

   STOR1    CONST   QOMN    QMN2    QOMX    QDMN    QDMX    QRTS    EFLT    QULD
 163000.    -1.00    -1.     -1.     -1.     -1.     -1.     -1.     0.      0.

  QUR      STMX      STMN     STMN2      PWR    PWRMX EFFCY TLWEL     QCAP EVAP
   0.       -1.       -1.       -1.       0.       0. 0.000    0.      -1.  -1.

ALOSS CLOSS    HYDLS    FULRS    OVLOD
   0.  0.0000 0.00000 619360.    1.000

         IOC     0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

         STORAGE, AREA, AND ELEVATION TABLE

           STORAGE            AREA          ELEVATION
              0.00            0.00             959.00
             58.40           20.80             964.00
            269.70           52.00             970.00
            608.90           71.10             976.00
           1373.00          225.20             982.00
           3787.00          597.40             988.00
           8688.00         1035.00             994.00
          16300.00         1511.00            1000.00
          26722.00         1985.00            1006.00
          40551.00         2704.00            1012.00
          59843.00         3744.00            1018.00
          85384.00         4723.00            1024.00
         116599.00         5696.00            1030.00
         154393.00         6935.00            1036.00
         200313.00         8404.00            1042.00
         255775.00        10165.00            1048.00
         299260.00        11667.00            1052.00
         349110.00        14442.00            1058.00
         472668.00        17436.00            1064.00
         587216.00        20806.00            1070.00
         630072.00        22061.00            1072.00

              OUTLET CAPACITY TABLE

         OUTLET CAPACITY           STORAGE
                    0.00         154394.00
                 2200.00         161562.00
                 2200.00         224106.00
                 3500.00         233325.00
                 3500.00         293638.00
                 4500.00         305230.00
                 4500.00         363556.00
                 5500.00         399669.00
                14500.00         459656.00
                34500.00         619358.00
```

Fig. 5.10. Sample output (ZOUT) from RESLYD.

PROGRAM - RESYLD DATE - 90/06/25. TIME - 10.47.50. PAGE - 4

MELVERN RESERVOIR ROUTING DATA SET
DATA FROM CORPS OF ENGINEERS

YEAR: 1940 CYCLE: 1

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	AC-FT EVAP	CFS TO PIPELINE REQ	ACTUAL	SHRTG	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE	RES QUAL
10	0.	26000.	100000.	158356.	163000.	1570.	30.	30.	0.	20.	20.	0.	7000.	4	0
11	0.	26000.	100000.	153814.	163000.	1567.	30.	30.	0.	20.	20.	0.	7000.	4	0
12	0.	26000.	100000.	150465.	163000.	274.	30.	30.	0.	20.	20.	0.	7000.	4	0
1	0.	26000.	100000.	146736.	163000.	39.	30.	30.	0.	30.	30.	0.	7000.	4	0
2	0.	26000.	100000.	143216.	163000.	188.	30.	30.	0.	30.	30.	0.	7000.	4	0
3	0.	26000.	100000.	137708.	163000.	1204.	30.	30.	0.	40.	40.	0.	7000.	4	0
4	0.	26000.	100000.	131241.	163000.	1707.	30.	30.	0.	50.	50.	0.	7000.	4	0
5	0.	26000.	100000.	126231.	163000.	91.	30.	30.	0.	50.	50.	0.	7000.	4	0
6	7.	26000.	100000.	120898.	163000.	963.	30.	30.	0.	50.	51.	0.	7000.	4	0
7	115.	26000.	100000.	119318.	163000.	3709.	30.	30.	0.	50.	50.	0.	7000.	5	0
8	13.	26000.	100000.	114873.	163000.	2137.	30.	30.	0.	20.	20.	0.	7000.	4	0
9	0.	26000.	100000.	110922.	163000.	977.	30.	30.	0.	20.	20.	0.	7000.	4	0
YR	11.					14426.	30.	30.	0.	33.	33.	0.	7000.		

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS ADD	REQ	ACTUAL	SHRTG	MAX	DOWNSTREAM QUALITY EFLT	REQ	ACTUAL
10	0.	0.	0.	0.	0.	20.	20.	0.	7000.	0.	0.	0.
11	0.	0.	0.	0.	0.	20.	20.	0.	7000.	0.	0.	0.
12	0.	0.	0.	0.	0.	20.	20.	0.	7000.	0.	0.	0.
1	0.	0.	0.	0.	0.	30.	30.	0.	7000.	0.	0.	0.
2	0.	0.	0.	0.	0.	30.	30.	0.	7000.	0.	0.	0.
3	0.	0.	0.	0.	0.	40.	40.	0.	7000.	0.	0.	0.
4	0.	0.	0.	0.	0.	50.	50.	0.	7000.	0.	0.	0.
5	0.	0.	0.	0.	0.	50.	50.	0.	7000.	0.	0.	0.
6	0.	0.	0.	0.	1.	50.	51.	0.	7000.	0.	0.	0.
7	0.	0.	0.	5.	1.	50.	55.	0.	7000.	0.	0.	0.
8	0.	0.	0.	1.	1.	20.	21.	0.	7000.	0.	0.	0.
9	0.	0.	0.	0.	0.	20.	20.	0.	7000.	0.	0.	0.
YR	0.	0.	0.	0.	0.	33.	34.	0.	7000.	0.	0.	0.

This data would be calculated for each year being analyzed.

MELVERN RESERVOIR ROUTING DATA SET
DATA FROM CORPS OF ENGINEERS

GRAND AVERAGE FOR CYCLE 1

PER	CFS INFLOW	END OF MONTH STORAGE IN AC-FT MIN	BUFFER	ACTUAL	MAX	AC-FT EVAP	CFS TO PIPELINE REQ	ACTUAL	SHRTG	RELEASE TO RIVER IN CFS REQ	ACTUAL	SHRTG	MAX	CASE	RES QUAL
YR	174.	26260.			184844.	14929.	30.	28.	2.	33.	125.	2.	7000.		

PER	1000 KW-HR POWER REQ	ACTUAL	SHRTG	FLOW IN CFS AT DOWNSTREAM CONTROL POINT QLOCAL	RIGHTS ADD	REQ	ACTUAL	SHRTG	MAX	DOWNSTREAM QUALITY EFLT	REQ	ACTUAL
YR	0.	0.	0.	117.	1.	33.	242.	2.	7000.	0.	0.	0.

SHORTAGE INDEX, PIPELINE 4.100 OUTLET 4.121 DOWNSTREAM 4.093 POWER 0.000

PIPE SHORTAGE: 792958. AC.-FT.
RIVER SHORTAGE: 3539654. AC.-FT.
DOWNSTREAM SHORTAGE: 60435. AC.-FT.

AVERAGE ANNUAL STORAGE USE:
PIPE 5943764.50 CFS
RIVER 9487258. CFS

Fig. 5.10. Continued.

Table 5.3. *Definitions of the variables in the RESYLD output.*

Variable	Definition
ALOS	Constant loss component between reservoir and downstream control point, for each period, in cubic feet per second (cfs).
ALOSS	Constant loss component between reservoir and downstream control point, for all periods in cfs. Calling index if negative.
AREA	Reservoir area in acres in reservoir contents table.
CASE	Index of the restriction being considered.
CLOSS	Loss coefficient applied to flow remaining after ALOS is subtracted to obtain remaining loss between reservoir and downstream control point.
CONST	Conversion factor from inflow units to acre-feet (if flow units are volumes) and from inflow units per day to cfs (if flow units are rates).
D/SNAT	Estimate of downstream flow without project.
EFFCY	Plant efficiency ratio, calling index if negative.
EFLT	Effluent in tons per day discharges for one period into river between reservoir and downstream control point.
ELEV	Reservoir elevation in stage table (in feet).
EVAP	Reservoir evaporation net change to project conditions (in inches per year), calling index if negative.
EVAPA	Reservoir evaporation (net change to project conditions) for period (in acre-feet).
FULRS	Reservoir capacity at full pool.
HYDLS	Hydraulic head loss, coefficient in equation H_{LOSS} = (HYDLS)/$Q^2/2g$ if positive; if negative, loss in feet.
IACFT	Positive integer indicates flow requirements are in acre-feet; zero indicates flow requirements are in cubic feet per second.
INFLOW	Flow from inflow-versus-quality table.
IPER	Number of first period in each year.
IPRNT	Indicates whether or not to print yearly statistics.
IYR	Year number.
NCMP	Number of cycles completed.
NCYCL	Number of cycles for job.
NDYS	Number of days in each period if same for all periods, calling index if negative.
NPER	Number of routing periods per year.
NSTOR	Number of storage values in table.
NYRS	Number of years in each run.
OVLOD	Maximum permissible power generated as a multiple of installed capacity.
POWER	Power (in thousand kilowatts per hour) actually generated in one period.
PWR	Minimum power (in thousand kilowatts per hour) required per period if same for all periods, calling index if negative.
PWRMX	Maximum permissible generation (in kilowatts).
QCAP	Outlet capacity (in cfs).
QD	Actual flow at downstream control point, including all water rights.
QDMN	Minimum permissible flow for period at downstream control point, excluding water rights.

Table 5.3. *Continued.*

Variable	Definition
QDMX	Maximum permissible flow at downstream control point for each period if same for all periods, including water rights, calling index if negative.
QLOCAL	Includes effect of water rights (calculated local inflow need).
QMN2	Minimum required outflow to pipeline for each period if same for all periods (see input data for units), calling index if negative.
QOMN	Minimum required outflow to river for each period if same for all periods (see input data for units), calling index if negative.
QOMX	Maximum permissible outflow (in cfs) to river for each period if same for all periods, calling index if negative.
QPIPE	Actual reservoir release (in cfs) to pipeline for period.
QRIVER	Actual reservoir release (in cfs) to river for period.
QRTS	Maximum water right for period (see input data for units).
QULD	Minimum required quality at downstream control point for each period if same for all periods (in parts per million or degrees of temperature), calling index if negative.
QUR	Reservoir quality for period (in parts per million or degrees of temperature).
RIGHTS	Required flow downstream at a control point.
STMN	Minimum storage (in acre-feet) for each period if same for all periods, calling index if negative.
STMN2	Storage (in acre-feet) greater than or equal to STMN below which shortage is declared, for each period if same for all periods, calling index if negative.
STMX	Maximum storage (in acre-feet) for each period if same for all periods, calling index if negative.
STOR1	Storage (in acre-feet) at start of routing cycle.
STORB	Storage (in acre-feet) at end of period.
TLWEL	Tailwater elevation (in feet).

RSTOMQ Program

Introduction

The RSTOMQ program converts the output file (ZRES) from the RESYLD program to a multirecord monthly flow file. This conversion enables the information from RESYLD to be further analyzed using the programs presented in Chapters 6–9.

Running RSTOMQ

RRSTOMQ, ZRES, ZMONQ

ZRES = RESYLD output file (input).

ZMONQ = Monthly flow file in USGS or NWDC format (output).

Figure 5.11 is a sample multirecord ZMONQ file created by the RSTOMQ program. The GET1 program could be used to extract a record(s) for further analysis.

```
ENTER   0 FOR NWDC FORMAT
        1 FOR USGS FORMAT
```

Specify the format of the output monthly flow file (ZMONQ).

```
RESYLD OUTPUT INCLUDES:
 PIPE FLOW FROM RESERVOIR
 RIVER FLOW FROM RESERVOIR AT DAM
 RIVER FLOW DOWNSTREAM
 RESERVOIR STORAGE
 RESERVOIR INFLOW
 UNREGULATED FLOW DOWNSTREAM
 RESERVOIR ELEVATION
 RESERVOIR EVAPORATION
 RESERVOIR SURFACE AREA
 DOWNSTREAM WATER RIGHTS
 POWER PRODUCTION.

FOR EACH SET OF RESYLD OUTPUT VALUES:
ENTER   0 TO SKIP THE CURRENT SET OF VALUES
        1 TO WRITE THE CURRENT SET OF VALUES
        2 TO WRITE ALL REMAINING SETS OF VALUES
        3 TO SKIP THE REMAINING SET OF VALUES

PIPE FLOW FROM RESERVOIR:
```

Below is a description of each option. Keep in mind that the actual data written to the monthly flow file depends on the point at which you enter these options. At this point, pipe flow from reservoir:

If 0 is selected: Pipe flow values will not be written to the monthly streamflow file. The set of options will then be displayed for river flow from reservoir at dam.

If 1 is selected: Pipe flow values will be written to the monthly streamflow file; then the set of options will be displayed for river flow from reservoir at dam.

If 2 is selected: *All* data from the ZRES file will be written to the monthly streamflow file in a multirecord format. No more prompts will be displayed.

If 3 is selected: Pipe flow from reservoir data will be the only data written to the monthly flow file. No more prompts will be displayed.

```
 PIPE FLOW
    MELVERN RESERVOIR ROUTING DATA SET
     DATA FROM CORPS OF ENGINEERS
QR911000     1940 1     30.00     30.00     30.00     30.00     30.00     30.00
QR911000     1940 2     30.00     30.00     30.00     30.00     30.00     30.00
QR911000     1941 1     30.00     30.00     30.00     30.00     30.00     30.00
QR911000     1941 2     30.00     30.00     30.00     30.00     30.00     30.00
#EOR
 RIVER FLOW FROM RESERVOIR AT DAM
    MELVERN RESERVOIR ROUTING DATA SET
     DATA FROM CORPS OF ENGINEERS
QR911000     1940 1     20.00     20.00     20.00     30.00     30.00     40.00
QR911000     1940 2     50.00     50.00     50.71     50.00     20.48     20.32
QR911000     1941 1     20.00     20.00     20.17     30.00     30.00     40.00
QR911000     1941 2     50.00     50.00     50.00     50.00     20.00     20.00
#EOR
 RIVER FLOW DOWNSTREAM
    MELVERN RESERVOIR ROUTING DATA SET
     DATA FROM CORPS OF ENGINEERS
QR911000     1940 1     20.00     20.00     20.00     30.00     30.00     40.00
QR911000     1940 2     50.00     50.00     51.00     54.58     21.00     20.33
QR911000     1941 1     20.00     21.44     21.00    487.70     33.06     42.10
QR911000     1941 2     50.00     50.00     58.48     52.78    701.80     23.45
```

Fig. 5.11. Sample output from the RSTOMQ program.

QABSDY Program

Introduction

The QABSDY program was designed to simulate the change in daily streamflows from a diversion (abstraction) from a river. QABSDY subtracts a diversion flow by day from a daily streamflow file while leaving a user-specified minimum flow in the main stream.

Running QABSDY

RQABSDY, ZDQ, ZDQD, ZDQR, ZDQN, ZOUT

ZDQ = Daily streamflow file in WATSTORE format or a free-formatted file with streamflows and dates (input).

ZDQD = Diversion streamflows in daily flow file format, or a free-formatted file with diversion flows and dates (input).

ZDQR = Required minimum instream streamflows in daily flow file format or a free-formatted file with required instream flows and dates (input).

ZDQN = Daily streamflow file with flows left after the diversion (output).

ZOUT = QABSDY results, including annual shortages and diversions (output).

The file format for the free-formatted ZDQ, ZDQD, and ZDQR file is

Line 1—Title line 1

Line 2—Title line 2

Line 3—Year number and how many data points will be entered.

Data for the first and last days of the year *must* be entered. Data for days not entered will be interpolated from the supplied data.

Line 4–n: Streamflow data for the number of data points specified on Line 3.

month day flow month day flow month day flow [etc.]

Sample free-formatted file:

```
FREE FORMATTED FILE FOR DAILY FLOW FILES (ZDQ, ZDQD, and ZDQR)
FOR USE WITH THE QABSDY PROGRAM
1971 12
10 1 300 11 1 300 12 1 300 1 1 300 2 1 300 3 1 300 4 1 400
5 1 450 6 1 450 6 1 450 7 1 450 8 1450 9 1 450
1972 300
10 1 300 .................. 9 1 450
```

The two title lines from the daily streamflow file (ZDQ) with the measured flows will be displayed.

```
INITIAL FLOW FILE FORMAT:
ENTER   0 FOR DAILY FLOW FILE FORMAT
        1 FOR FREE-FORMATTED FLOW POINT FILE
```

The daily flow file format is a daily streamflow file in WATSTORE format with a value entered for each day of the year. The free-formatted flow point file may or may not contain data for each day of the year. Streamflows for days not supplied will be interpolated from the data supplied.

The two title lines from the diversion data file (ZDQD) will be displayed.

```
DIVERSION FLOW FILE FORMAT:
ENTER   0 FOR DAILY FLOW FILE FORMAT
        1 FOR FREE-FORMATTED FLOW POINT FILE
```

The two title lines from the flow requirement file (ZDQR) will be displayed.

```
REQUIRED MINIMUM FLOW FILE FORMAT:
ENTER   0 FOR DAILY FLOW FILE FORMAT
        1 FOR FREE-FORMATTED FLOW POINT FILE
ENTER   1 TO LIST DAILY VALUES
        2 TO LIST MONTHLY AVERAGES ONLY
```

If 1 is entered to list daily values, a table will be generated for each year with the original flow, diversion flow, and required flow for each day of the year.

If 2 is entered to list only monthly averages, the output will be similar to the QABSMN program output (Fig. 5.12).

QABSMN Program

Introduction

The QABSMN program was designed to simulate the change in monthly streamflows from a diversion (abstraction) from a river. QABSMN subtracts a diversion flow by month from a monthly streamflow file while leaving a user-specified minimum flow in the main stream.

For example, an irrigation company proposes to divert a set amount of flows from a stream each month. An instream flow analysis has determined the required flows per month to maintain the habitat area. The QABSMN program could be run to determine if and where a conflict will arise, considering the history of the monthly flows for that section of the stream.

The monthly streamflow data may be in either NWDC or USGS format. The program will write a file of monthly flows (Q_{ds}) downstream of the diversion in the same format as the file of monthly flows supplied.

Running QABSMN

RQABSMN, ZMONQ, ZMONQN, ZOUT

ZMONQ = Monthly streamflow file in USGS or NWDC format (input).

ZMONQN = Monthly streamflow file in the same format as the ZMONQ input file, with diversion flows subtracted from the monthly flows (output).

ZOUT = QABSMN results, including annual shortages and diversions (output).

```
ENTER INDEX TO FIRST MONTH OF DATA (OCT. = 10, JAN. = 1):
```

This index will label the first data entry on the input streamflow file with the corresponding month name. For example, if the first monthly entry on the streamflow file is October, enter 10. If the first entry on the data file is January, enter 1.

```
ENTER 12 MONTHLY DIVERSION DEMANDS:
```

Enter the monthly flows that the diversion is proposing.

> To repeat a number, enter repeat factor*value.
> Example: 6*250 = entering 250 six times.

```
ENTER 12 MINIMUM REQUIREMENT INSTREAM FLOW NEEDS:
```

Enter the 12 monthly flows that are needed to support the habitat. Again, to repeat a number, enter repeat factor*value.

The average annual diversion (in acre-feet), an annual diversion-versus-year plot, and the average annual diversion shortage (in acre-feet) are displayed on the screen. Figure 5.12 contains sample output from the ZOUT file from the QABSMN program; Fig. 5.13 is a ZMONQN file from QABSMN.

DATE - 90/06/18. NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH 1214200000 PROGRAM - QABSMN
TIME - 13.42.53. MEAN MONTHLY DISCHARGE - 1962 THRU 1977 PAGE - 1

MONTH	DIVERSION TARGET	INSTREAM FLOW REQUIREMENT
OCT	250.00	300.00
NOV	250.00	300.00
DEC	250.00	300.00
JAN	250.00	300.00
FEB	250.00	300.00
MAR	250.00	300.00
APR	275.00	400.00
MAY	300.00	450.00
JUNE	300.00	450.00
JULY	300.00	450.00
AUG	300.00	450.00
SEPT	275.00	450.00

DATE - 90/06/18. NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH 1214200000 PROGRAM - QABSMN
TIME - 13.42.53. MEAN MONTHLY DISCHARGE - 1962 THRU 1977 PAGE - 2

GIVEN MONTHLY FLOWS

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1962	523.00	479.00	715.00	865.00	363.00	243.00	709.00	510.00	568.00	318.00	281.00	197.00
1963	300.00	721.00	748.00	421.00	686.00	314.00	523.00	456.00	394.00	247.00	125.00	149.00
1964	315.00	751.00	549.00	668.00	380.00	412.00	533.00	846.00	1219.00	692.00	439.00	405.00
1965	365.00	568.00	742.00	920.00	771.00	329.00	637.00	587.00	461.00	222.00	146.00	243.00
1966	352.00	475.00	429.00	543.00	275.00	472.00	666.00	798.00	599.00	424.00	120.00	78.00
1967	405.00	605.00	999.00	1054.00	572.00	389.00	284.00	747.00	771.00	244.00	71.00	73.00
1968	760.00	488.00	996.00	853.00	917.00	428.00	479.00	682.00	705.00	221.00	238.00	462.00
1969	578.00	736.00	603.00	732.00	201.00	408.00	625.00	1013.00	764.00	249.00	90.00	401.00
1970	413.00	377.00	498.00	713.00	545.00	391.00	523.00	540.00	536.00	182.00	90.00	359.00
1971	364.00	589.00	480.00	938.00	834.00	397.00	444.00	1054.00	875.00	717.00	177.00	208.00
1972	374.00	788.00	537.00	651.00	1125.00	1250.00	682.00	1170.00	998.00	733.00	181.00	69.00
1973	171.00	392.00	972.00	577.00	219.00	275.00	353.00	523.00	493.00	162.00	64.00	145.00
1974	431.00	574.00	805.00	1105.00	453.00	670.00	620.00	877.00	1338.00	725.00	263.00	92.00
1975	51.00	528.00	768.00	919.00	439.00	428.00	279.00	854.00	802.00	564.00	307.00	163.00
1976	518.00	962.00	1556.00	996.00	343.00	244.00	480.00	785.00	645.00	491.00	323.00	157.00
1977	153.00	388.00	485.00	500.00	325.00	332.00	605.00	535.00	439.00	142.00	141.00	262.00
AVE	379.56	588.81	742.62	778.44	528.00	436.37	527.62	748.56	725.44	395.81	191.00	235.19
C.V.	0.4527	0.2801	0.3875	0.2663	0.5110	0.5497	0.2567	0.2875	0.3774	0.5647	0.5623	0.5405

UNITS ARE CUBIC FEET PER SECOND

MONTHLY DIVERSION

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1962	223.00	179.00	250.00	250.00	63.00	0.00	275.00	60.00	118.00	0.00	0.00	0.00
1963	0.00	250.00	250.00	121.00	250.00	14.00	123.00	6.00	0.00	0.00	0.00	0.00
1964	15.00	250.00	249.00	250.00	80.00	112.00	133.00	300.00	300.00	242.00	0.00	0.00
1965	65.00	250.00	250.00	250.00	250.00	29.00	237.00	137.00	11.00	0.00	0.00	0.00
1966	52.00	175.00	129.00	243.00	0.00	172.00	266.00	300.00	149.00	0.00	0.00	0.00
1967	105.00	250.00	250.00	250.00	250.00	89.00	0.00	297.00	300.00	0.00	0.00	0.00
1968	250.00	188.00	250.00	250.00	250.00	128.00	79.00	232.00	255.00	0.00	0.00	12.00
1969	250.00	250.00	250.00	250.00	0.00	108.00	225.00	300.00	300.00	0.00	0.00	0.00
1970	113.00	77.00	198.00	250.00	245.00	91.00	123.00	90.00	86.00	0.00	0.00	0.00
1971	64.00	250.00	180.00	250.00	250.00	97.00	44.00	300.00	300.00	267.00	0.00	0.00
1972	74.00	250.00	237.00	250.00	250.00	250.00	275.00	300.00	300.00	283.00	0.00	0.00
1973	0.00	92.00	250.00	250.00	0.00	0.00	0.00	73.00	43.00	0.00	0.00	0.00
1974	131.00	250.00	250.00	250.00	153.00	250.00	220.00	300.00	300.00	275.00	0.00	0.00
1975	0.00	228.00	250.00	250.00	139.00	128.00	0.00	300.00	300.00	114.00	0.00	0.00
1976	218.00	250.00	250.00	250.00	43.00	0.00	80.00	300.00	195.00	41.00	0.00	0.00
1977	0.00	88.00	185.00	200.00	25.00	32.00	205.00	85.00	0.00	0.00	0.00	0.00
AVE	97.50	204.81	229.87	238.37	140.50	93.75	142.81	211.25	184.81	76.37	0.00	0.75
C.V	0.9468	0.317	0.1595	0.1413	0.7682	0.8648	0.7128	0.5343	0.6730	1.5378	0.0000	4.0000

UNITS ARE CUBIC FEET PER SECOND

Fig. 5.12. Sample output (ZOUT) file from the QABSMN program.

DATE - 90/06/18. NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH 1214200000 PROGRAM - QABSMN
TIME - 13.42.53. MEAN MONTHLY DISCHARGE - 1962 THRU 1977

SHORTAGE TABLE

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1962	27.00	71.00	0.00	0.00	187.00	250.00	0.00	240.00	182.00	300.00	300.00	275.00
1963	250.00	0.00	0.00	129.00	0.00	236.00	152.00	294.00	300.00	300.00	300.00	275.00
1964	235.00	0.00	1.00	0.00	170.00	138.00	142.00	0.00	0.00	58.00	300.00	275.00
1965	185.00	0.00	0.00	0.00	0.00	221.00	38.00	163.00	289.00	300.00	300.00	275.00
1966	198.00	75.00	121.00	7.00	250.00	78.00	9.00	0.00	151.00	300.00	300.00	275.00
1967	145.00	0.00	0.00	0.00	0.00	161.00	275.00	3.00	0.00	300.00	300.00	275.00
1968	0.00	62.00	0.00	0.00	0.00	122.00	196.00	68.00	45.00	300.00	300.00	263.00
1969	0.00	0.00	0.00	0.00	250.00	142.00	50.00	0.00	0.00	300.00	300.00	275.00
1970	137.00	173.00	52.00	0.00	5.00	159.00	152.00	210.00	214.00	300.00	300.00	275.00
1971	186.00	0.00	70.00	0.00	0.00	153.00	231.00	0.00	0.00	33.00	300.00	275.00
1972	176.00	0.00	13.00	0.00	0.00	0.00	0.00	0.00	0.00	17.00	300.00	275.00
1973	250.00	158.00	0.00	0.00	250.00	250.00	275.00	227.00	257.00	300.00	300.00	275.00
1974	119.00	0.00	0.00	0.00	97.00	0.00	55.00	0.00	0.00	25.00	300.00	275.00
1975	250.00	22.00	0.00	0.00	111.00	122.00	275.00	0.00	0.00	186.00	300.00	275.00
1976	32.00	0.00	0.00	0.00	207.00	250.00	195.00	0.00	105.00	259.00	300.00	275.00
1977	250.00	162.00	65.00	50.00	225.00	218.00	70.00	215.00	300.00	300.00	300.00	275.00
AVE	152.50	45.19	20.12	11.62	109.50	156.25	132.19	88.75	115.19	223.62	300.00	274.25
C.V.	0.6054	1.4394	1.8216	2.8983	0.9857	0.5189	0.7701	1.2717	1.0798	0.5252	0.0000	0.0109

UNITS ARE CUBIC FEET PER SECOND

MONTHLY INSTREAM FLOWS

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1962	300.00	300.00	465.00	615.00	300.00	243.00	434.00	450.00	450.00	318.00	281.00	197.00
1963	300.00	471.00	498.00	300.00	436.00	300.00	400.00	450.00	394.00	247.00	125.00	149.00
1964	300.00	501.00	300.00	418.00	300.00	300.00	400.00	546.00	919.00	450.00	439.00	405.00
1965	300.00	318.00	492.00	670.00	521.00	300.00	400.00	450.00	450.00	222.00	146.00	243.00
1966	300.00	300.00	300.00	300.00	275.00	300.00	400.00	498.00	450.00	424.00	120.00	78.00
1967	300.00	355.00	749.00	804.00	322.00	300.00	284.00	450.00	471.00	244.00	71.00	73.00
1968	510.00	300.00	746.00	603.00	667.00	300.00	400.00	450.00	450.00	221.00	238.00	450.00
1969	328.00	486.00	353.00	482.00	201.00	300.00	400.00	713.00	464.00	249.00	90.00	401.00
1970	300.00	300.00	300.00	463.00	300.00	300.00	400.00	450.00	450.00	182.00	90.00	359.00
1971	300.00	339.00	300.00	688.00	584.00	300.00	400.00	754.00	575.00	450.00	177.00	208.00
1972	300.00	538.00	300.00	401.00	875.00	1000.00	407.00	870.00	698.00	450.00	181.00	369.00
1973	171.00	300.00	722.00	327.00	219.00	275.00	353.00	450.00	450.00	162.00	64.00	145.00
1974	300.00	324.00	555.00	855.00	300.00	420.00	400.00	577.00	1038.00	450.00	263.00	92.00
1975	51.00	300.00	518.00	669.00	300.00	300.00	279.00	554.00	502.00	450.00	307.00	163.00
1976	300.00	712.00	1306.00	746.00	300.00	244.00	400.00	485.00	450.00	450.00	323.00	157.00
1977	153.00	300.00	300.00	300.00	300.00	300.00	400.00	450.00	439.00	142.00	141.00	262.00
AVE	282.06	384.00	512.75	540.06	387.50	342.62	384.81	537.31	540.62	319.44	191.00	234.44
C.V.	0.3425	0.3176	0.5245	0.3507	0.4750	0.5234	0.1119	0.2430	0.3437	0.3821	0.5623	0.5363

UNITS ARE CUBIC FEET PER SECOND

Fig. 5.12. *Continued.*

```
DATE - 90/06/18.    NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH    1214200000    PROGRAM - QABSMN
TIME - 13.42.53.    MEAN MONTHLY DISCHARGE - 1962 THRU 1977
```

INSTREAM FLOW SHORTAGES

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1962	0.00	0.00	0.00	0.00	0.00	57.00	0.00	0.00	0.00	132.00	169.00	253.00
1963	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56.00	203.00	325.00	301.00
1964	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00	45.00
1965	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	228.00	304.00	207.00
1966	0.00	0.00	0.00	0.00	25.00	0.00	0.00	0.00	0.00	26.00	330.00	372.00
1967	0.00	0.00	0.00	0.00	0.00	0.00	116.00	0.00	0.00	206.00	379.00	377.00
1968	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	229.00	212.00	0.00
1969	0.00	0.00	0.00	0.00	99.00	0.00	0.00	0.00	0.00	201.00	360.00	49.00
1970	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	268.00	360.00	91.00
1971	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	273.00	242.00
1972	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	269.00	81.00
1973	129.00	0.00	0.00	0.00	81.00	25.00	47.00	0.00	0.00	288.00	386.00	305.00
1974	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	187.00	358.00
1975	249.00	0.00	0.00	0.00	0.00	0.00	121.00	0.00	0.00	0.00	143.00	287.00
1976	0.00	0.00	0.00	0.00	0.00	56.00	0.00	0.00	0.00	0.00	127.00	293.00
1977	147.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00	308.00	309.00	188.00
AVE	32.81	0.00	0.00	0.00	12.81	8.62	17.75	0.00	4.19	130.56	259.00	215.56
C.V.	2.2673	0.0000	0.0000	0.0000	2.4149	2.2837	2.3121	0.0000	3.3639	0.9348	0.4147	0.5832

UNITS ARE CUBIC FEET PER SECOND

ANNUAL DIVERSION

1962	85530.06	1963	60015.78	1964	116855.64
1965	88309.98	1966	90042.48	1967	107357.58
1968	114206.41	1969	117113.04	1970	76115.16
1971	120221.64	1972	148923.73	1973	43189.74
1974	143589.61	1975	103027.33	1976	98655.48
1977	49602.96				

AVERAGE IS 97672.

C.V. IS 0.3110

UNITS ARE ACRE-FEET

```
DATE - 90/06/18.    NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH    1214200000    PROGRAM - QABSMN
TIME - 13.42.53.    MEAN MONTHLY DISCHARGE - 1962 THRU 1977
```

ANNUAL DIVERSION VERSUS YEAR

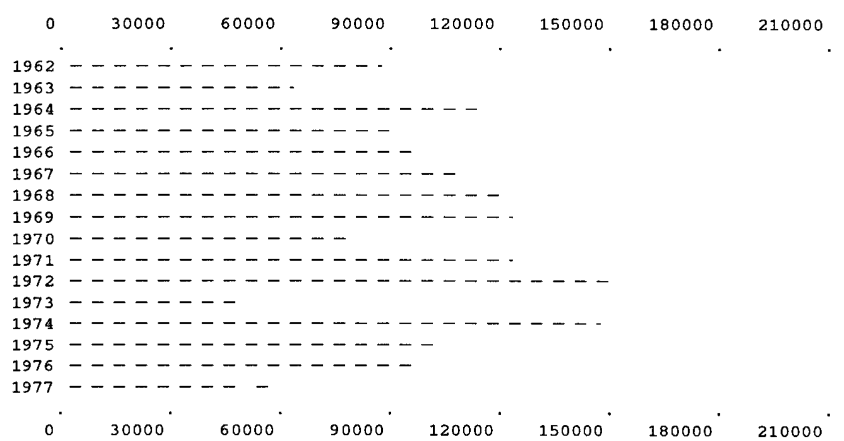


Fig. 5.12. *Continued.*

```
     ANNUAL DIVERSION SHORTAGE

1962      110291     1963      135806     1964       79461
1965      107512     1966      105779     1967       88464
1968       82110     1969       78708     1970      119706
1971       75600     1972       47393     1973      152632
1974       52232     1975       92794     1976       97661
1977      146219

     AVERAGE IS       98273.

           C.V. IS    0.3081


     UNITS ARE ACRE-FEET


     ANNUAL SHORTAGE AS PERCENT OF THE DESIRED DIVERSION

1962       56.32     1963       69.35     1964       40.58
1965       54.90     1966       54.02     1967       45.18
1968       41.93     1969       40.19     1970       61.13
1971       38.61     1972       24.20     1973       77.94
1974       26.67     1975       47.39     1976       49.87
1977       74.67
```

Fig. 5.12. *Continued.*

NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH 1214200000
MEAN MONTHLY DISCHARGE - 1962 THRU 1977 (POST-DIVERSION)

12142000	1962	1	300.00	300.00	465.00	615.00	300.00	243.00
12142000	1962	2	434.00	450.00	450.00	318.00	281.00	197.00
12142000	1963	1	300.00	471.00	498.00	300.00	436.00	300.00
12142000	1963	2	400.00	450.00	394.00	247.00	125.00	149.00
12142000	1964	1	300.00	501.00	300.00	418.00	300.00	300.00
12142000	1964	2	400.00	546.00	919.00	450.00	439.00	405.00
12142000	1965	1	300.00	318.00	492.00	670.00	521.00	300.00
12142000	1965	2	400.00	450.00	450.00	222.00	146.00	243.00
12142000	1966	1	300.00	300.00	300.00	300.00	275.00	300.00
12142000	1966	2	400.00	498.00	450.00	424.00	120.00	78.00
12142000	1967	1	300.00	355.00	749.00	804.00	322.00	300.00
12142000	1967	2	284.00	450.00	471.00	244.00	71.00	73.00
12142000	1968	1	510.00	300.00	746.00	603.00	667.00	300.00
12142000	1968	2	400.00	450.00	450.00	221.00	238.00	450.00
12142000	1969	1	328.00	486.00	353.00	482.00	201.00	300.00
12142000	1969	2	400.00	713.00	464.00	249.00	90.00	401.00
12142000	1970	1	300.00	300.00	300.00	463.00	300.00	300.00
12142000	1970	2	400.00	450.00	450.00	182.00	90.00	359.00
12142000	1971	1	300.00	339.00	300.00	688.00	584.00	300.00
12142000	1971	2	400.00	754.00	575.00	450.00	177.00	208.00
12142000	1972	1	300.00	538.00	300.00	401.00	875.00	1000
12142000	1972	2	407.00	870.00	698.00	450.00	181.00	369.00
12142000	1973	1	171.00	300.00	722.00	327.00	219.00	275.00
12142000	1973	2	353.00	450.00	450.00	162.00	64.00	145.00
12142000	1974	1	300.00	324.00	555.00	855.00	300.00	420.00
12142000	1974	2	400.00	577.00	1038	450.00	263.00	92.00
12142000	1975	1	51.00	300.00	518.00	669.00	300.00	300.00
12142000	1975	2	279.00	554.00	502.00	450.00	307.00	163.00
12142000	1976	1	300.00	712.00	1306	746.00	300.00	244.00
12142000	1976	2	400.00	485.00	450.00	450.00	323.00	157.00
12142000	1977	1	153.00	300.00	300.00	300.00	300.00	300.00
12142000	1977	2	400.00	450.00	439.00	142.00	141.00	262.00

Fig. 5.13. Sample output (ZMONQ file) from the QABSMN program.

Chapter 6. Generation and Analysis of Daily Streamflow and Habitat Values

Introduction

Monthly time steps are used in most instream flow studies, because of the convenience and the fact that programs have not been written to use shorter time steps. Until recently, the vast majority of applications did not deal with projects requiring a daily time step. Daily values of streamflow will likely be used in the evaluation of small hydro projects. At this time, the only program available that uses daily streamflow data directly is the HABTD program.

The HABTD program uses daily streamflows and the habitat area-versus-streamflow relation (ZHAQF file) to develop both monthly and daily values of habitats. The monthly values are developed from the daily values of habitat.

The USGS's WATSTORE data base contains flow values recorded at a variety of frequencies. Programs exist within the WATSTORE data base system that will determine probability of exceedence curves for flow values at those frequencies. The same probability of exceedence concepts have been applied to the amount of weighted usable habitat area available in the study reach because habitat area is the important variable to any study species.

The daily habitat exceedence program (DQDUR) uses information gained from a daily flow duration analysis and the habitat area-versus-flow relation to define a daily habitat probability exceedence curve. Each exceedence curve is applicable only for a particular life stage of species at a given study site.

The first step in obtaining the daily habitat exceedence is to run the flow duration analysis program associated with the USGS's data base. The TSLIB program DURTBL is used to generate a "Daily Streamflow Values Duration Table" request file to retrieve the data from the WATSTORE data base.

The duration analysis file obtained from WATSTORE contains a ranking and the probability of exceedence for flows occurring during a given day of a particular month. This extremely large file can be reduced by the SELDUR program into a file that contains just the important flow duration table. Either the reduced file or the original WATSTORE file can be used as input to the DQDUR program, which has options to calculate class distribution, habitat exceedence values and graphs, and (or) duration percentages. (Refer to Chapter 2 for DURTBL and SELDUR program documentation.)

> Note: Highly variable daily flows may invalidate the use of a "standard" habitat area-versus-streamflow function. You are responsible for making sure that the calculated habitat values are biologically relevant. Using PHABSIM's HABEF program may be a better approach under some circumstances.

Daily Habitat Time Series Generation

Program Name	Batch/Procedure Filename	Function	Program Description
DQDUR	**RDQDUR**	Daily habitat probability exceedence generation	Processes a WATSTORE duration analysis file with these options: 0 = class distribution statistics, 1 = habitat exceedence values and graphs and class distribution statistics, 2 = duration percentages, or 3 = all three. **RDQDUR, WATDUR, ZOUT, ZHAQF, ZCLASS, ZEXPLT, ZMONTH, ZVAR, ZREDUR** **WATDUR** = WATSTORE duration analysis file. Can be directly from WATSTORE (generated by submitting the request job created by the DURTBL program) or the reduced file created by the SELDUR program (input). **ZOUT** = File containing a list of headings from the duration analysis file (output). **ZHAQF** = Habitat-versus-streamflow file. Only needed if Options 1 or 3 are selected (input). If not needed, enter ZZZ for this file. **ZCLASS** = Class distribution statistics, created by Options 0, 1, and 3 (output). **ZEXPLT** = File containing exceedence plots, created by Options 1 and 3 (output). **ZMONTH** = File containing monthly exceedence statistics, created by Options 1 and 3 (output). **ZVAR** = File of percentage of exceeded flows and variation ratios, created by Options 2 and 3 (output). **ZREDUR** = Reduced WATSTORE duration analysis file (output).
HABTD	**RHABTD**	Daily habitat time series generation	Calculates the time series of daily habitat values and converts these to monthly habitat time series using user-supplied criteria. **RHABTD, ZHAQF, ZDQ, ZMTS, ZOUT, DAYFL** **ZHAQF** = Habitat-versus-flow file (input). **ZDQ** = Daily streamflow file in WATSTORE format (must have been run through DQFY to strip incomplete years and excess title lines (input). **ZMTS** = Monthly habitat time series file in NWDC format, one logical record per life stage (output). **ZOUT** = HABTD results (output). **DAYFL** = File of daily habitat values in either report or Lotus 1-2-3 format. Created when daily habitat values are requested (output).

DQDUR Program

Introduction

The DQDUR program processes a WATSTORE duration analysis file with several options. The WATSTORE duration analysis file contains a ranking and the probability of exceedence for flows occurring on a given day of a particular month. The duration analysis file used as input to the DQDUR program can be directly from WATSTORE (generated by submitting the request job created by the DURTBL program) or the reduced file created by the SELDUR program. Chapter 2 contains documentation for the DURTBL and SELDUR programs.

In other words, DQDUR can produce a daily habitat duration table from a daily flow duration table without directly computing the habitat value for every day—it samples 100 flows from the flow duration table and thereby can allow you to avoid downloading and processing a master data file.

Running DQDUR

RDQDUR, WATDUR, ZOUT, ZHAQF, ZCLASS, ZEXPLT, ZMONTH, ZVAR, ZREDUR

WATDUR = WATSTORE duration analysis file. Can be directly from WATSTORE (generated by submitting the request job created by the DURTBL program) or the reduced file created by the SELDUR program (input).

ZOUT = File containing a list of headings from the duration analysis file (output).

ZHAQF = Habitat-versus-streamflow file. Only needed if options 1 or 3 are selected (input). If not needed, enter ZZZ for this file.

ZCLASS = Class distribution statistics, created by options 0, 1, and 3 (output).

ZEXPLT = File containing exceedence plots, created by options 1 and 3 (output).

ZMONTH = File containing monthly exceedence statistics, created by options 1 and 3 (output).

ZVAR = File of percentage exceeded flows and variation ratios, created by options 2 and 3 (output).

ZREDUR = Reduced WATSTORE duration analysis file. Created if WATDUR was directly from WATSTORE (output).

```
DAILY FLOW DURATION ANALYSIS
****************************
PROCESSING WATSTORE FILE, THIS MAY TAKE A WHILE
ENTER   0 FOR CLASS STATISTICS
        1 FOR EXCEEDENCE PLOTS AND CLASS STATISTICS
        2 FOR DURATION PERCENTAGES
        3 FOR ALL THREE
```

Description of DQDUR program options:

0 = Class distribution statistics—creates a data file that contains the classes, flow values, and probability of exceedence for each flow for each month.

1 = Habitat exceedence values and graphs, plus class distribution statistics. This option takes the probability of low exceedence curve and determines the flows corresponding to all exceedence percentages occurring at one percent intervals for the entire range defined on a curve. It then interpolates either linearly or by polynomial representatives for the weighted usable area (WUA) values from the flows. Polynomial interpolation is applicable when the data can be fit easily by a third order equation; otherwise, linear interpolation should be used. The WUA values are then ranked in ascending order, and the probability of exceedence is determined for a given habitat value from its ranking relative to the total range of habitat values. Thus, the habitat probability of the exceedence curve is determined based on the probability of exceedence for flows occurring on a daily basis during a particular month. This curve, however, is only indirectly related to the flow exceedence curve. Therefore, there is not a one-to-one correspondence between the two curves.

2 = Duration percentages—writes a file containing the flow exceedence curve information determined in the duration analysis.

3 = Does all three analyses.

If option 1 or 3 is selected, the following prompts will appear:

```
WATSTORE FILE:
ENTER   1 TO USE POLYNOMIAL FUNCTION FOR INTERPOLATION
        0 TO USE LINEAR INTERPOLATION
```

This prompt will be asked for both the WATSTORE duration analysis file and the habitat-versus-streamflow file used as input to DQDUR. Polynomial interpolation is

applicable when the data can be fit easily by a third order equation; otherwise, linear interpolation should be used. If option 1 is selected, the program will issue a warning because it could give negative or irrational results for nonlinear extrapolation. Do not use this option unless you are prepared to handle this.

```
STATION NUMBERS ON DURATION ANALYSIS FILE:
```

The station numbers are listed.

```
ENTER NUMBER OF STATIONS TO COMPUTE DURATION RELATIONSHIP:
ENTER THE STATION NUMBERS:
```

Figures 6.1–6.5 contain sample outputs from the DQDUR program—a portion of sample output is included from each of the files created.

```
 1
JANUARY
 DURATION PLOT OF DAILY DATA FOR
(YEARS 1930 - 1989)
 STATION ID 12142000            N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
DRAINAGE AREA =       64.00 SQ. MI.

 2
FEBRUARY
 DURATION PLOT OF DAILY DATA FOR
(YEARS 1930 - 1990)
 STATION ID 12142000            N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
DRAINAGE AREA =       64.00 SQ. MI.
```

Fig. 6.1. Sample output (ZOUT) from the DQDUR program. This file contains a list of headings from the duration analysis file.

```
STATION ID 12142000            N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
DURATION PLOT OF DAILY DATA FOR      (YEARS 1930 - 1989)
DRAINAGE AREA =       64.00 SQ. MI.

CLASS  STATION ID        FLOW   PERCENT EXCEEDENCE PER MONTH
  0      12142000         0.0   100.00   100.00   100.00   100.00   100.00   100.00
         12142000               100.00   100.00   100.00   100.00   100.00   100.00
  1      12142000        33.0   100.00   100.00   100.00   100.00   100.00   100.00
         12142000               100.00   100.00   100.00   100.00   100.00   100.00
  2      12142000        39.0   100.00   100.00   100.00   100.00   100.00   100.00
         12142000               100.00    99.21    98.37    98.55    99.66   100.00
  3      12142000        46.0   100.00   100.00   100.00   100.00   100.00   100.00
         12142000               100.00    95.39    95.65    96.58    99.32   100.00
  4      12142000        54.0   100.00   100.00   100.00   100.00   100.00   100.00
         12142000                99.28    89.34    90.34    94.14    99.32   100.00
  5      12142000        64.0   100.00   100.00   100.00   100.00   100.00   100.00
         12142000                97.76    78.14    83.33    91.51    99.18   100.00
```

Fig. 6.2. Sample output (ZCLASS) from the DQDUR program. This file contains class distribution statistics.

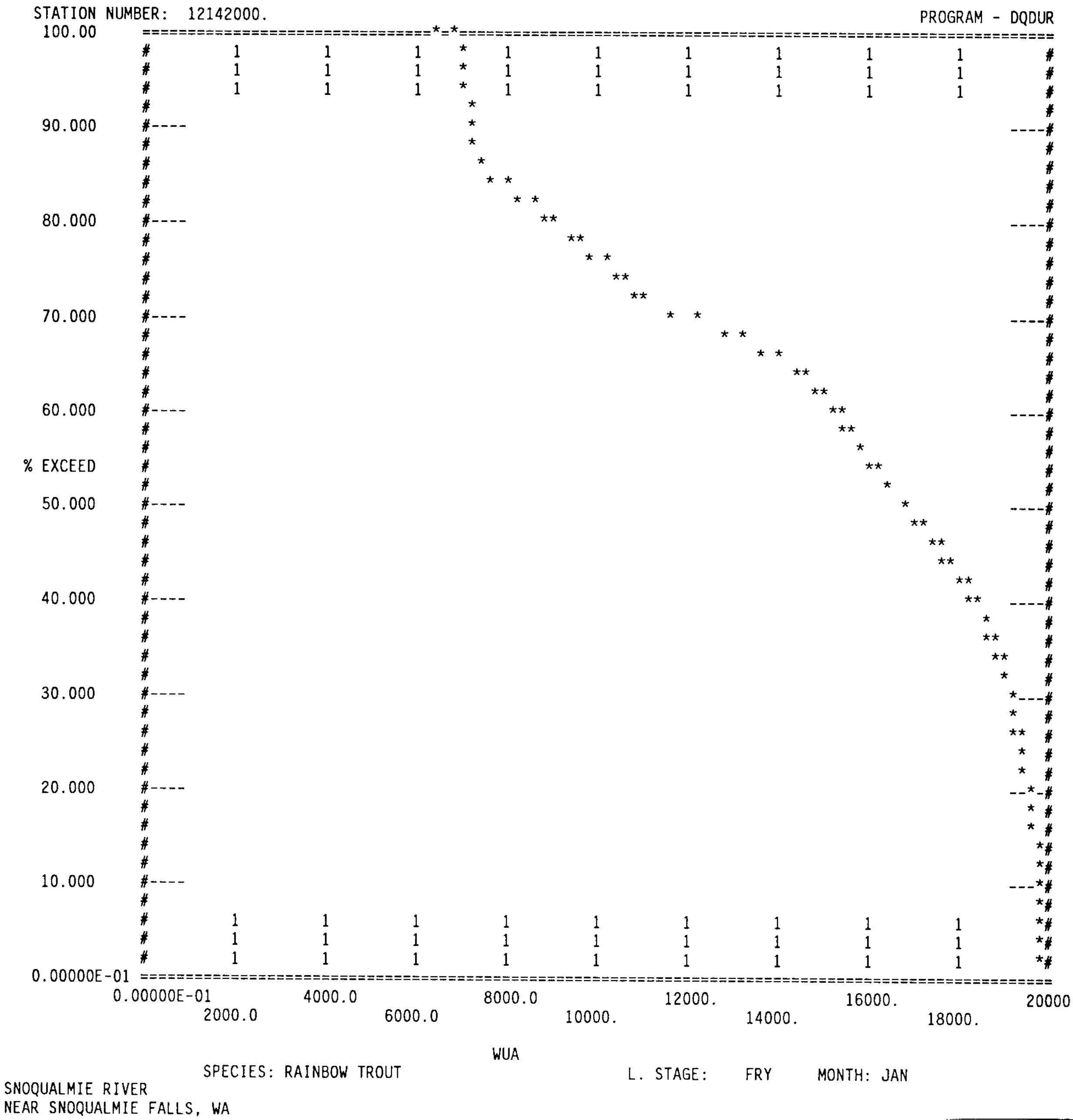


Fig. 6.3. Sample output (ZEXPLT) from the DQDUR program. This file contains exceedence plots for each month, for each species and life stage in the ZHAQF file.

```
SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
    STATION NUMBER:  12142000.
RAINBOW TROUT                                         FRY
          MONTH: JAN
          HABITAT AREA    PERCENT EXCEEDENCE
              19789.58         0.99
              19788.79         1.98
              19788.01         2.97
              19787.22         3.96
              19786.43         4.95
              19785.64         5.94
              19784.85         6.93
              19784.06         7.92
              19783.28         8.91
              19782.49         9.90
              19781.66        10.89
              19780.77        11.88
              19771.31        12.87
              19753.96        13.86
              19711.35        14.85
```

Fig. 6.4. Sample output (ZMONTH) from the DQDUR program. This very large file contains monthly exceedence statistics for each species and life stage in the ZHAQF file.

STATION ID 12142000 N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
ANALYSIS FOR PERIOD OF RECORD (YEARS 1930 - 1989)

MONTH	Q95	Q90	Q75	Q70	Q50	Q25	Q10	VR
*******	*******	*******	*******	*******	*******	*******	*******	*******
JANUARY	140.0	168.0	230.0	251.0	371.0	690.0	1330.0	2.21
FEBRUARY	138.0	158.0	223.0	243.0	333.0	548.0	984.0	2.11
MARCH	176.0	197.0	252.0	269.0	356.0	542.0	860.0	1.81
APRIL	249.0	278.0	354.0	381.0	488.0	697.0	972.0	1.76
MAY	325.0	370.0	476.0	507.0	651.0	894.0	1210.0	1.76
JUNE	206.0	274.0	390.0	422.0	568.0	812.0	1130.0	2.07
JULY	78.3	95.2	140.0	157.0	235.0	388.0	620.0	2.47
AUGUST	46.5	53.1	67.1	72.1	96.8	154.0	256.0	1.82
SEPTEMBER	47.0	54.5	75.7	82.4	118.0	235.0	474.0	2.17
OCTOBER	51.2	69.5	111.0	126.0	205.0	435.0	821.0	2.95
NOVEMBER	115.0	162.0	254.0	285.0	435.0	748.0	1350.0	2.69
DECEMBER	171.0	201.0	281.0	308.0	450.0	812.0	1550.0	2.24

DRAINAGE AREA = 64.00 SQ. MI.

VR = VARIATION RATIO (Q50/Q90)

Fig. 6.5. Sample output (ZVAR) from the DQDUR program. This file contains the percentage for exceeded flows and variation ratios.

HABTD Program

Introduction

The HABTD program calculates the time series of daily habitat values and converts these to monthly habitat time series from user-supplied criteria.

Running HABTD

RHABTD, ZHAQF, ZDQ, ZMTS, ZOUT, DAYFL

ZHAQF = Habitat area-versus-flow file (input).

ZDQ = Daily streamflow file in WATSTORE format (input). (File must have been run through the DQFY program to strip incomplete years and excess title lines.)

ZMTS = Monthly habitat data in NWDC format, one logical record per life stage (output).

ZOUT = HABTD results (output).

DAYFL = File of daily habitat values in either report or Lotus 1-2-3 format. Created when daily habitat values are requested (output).

```
ENTER RECORD NAME (5 CHAR)
```

On the ZMTS output file, the data for each species and life stage is written as a separate section terminated by "#EOR" and is preceded by a header-line containing a user-designated label and a sequential numbering system.

For example, if CLASS is entered here as the record name, the very top line on the ZMTS file will contain the letters CLASSA1. Following this line will be two title lines and then the habitat data for the first species, first life stage. Next there will be a line containing the letters CLASSA2, followed by two title lines and the data for the first species, second life stage. Following all life stages of the first species, the line will contain CLASSB1 for the second species, first life stage, and so forth. In other words, each species will begin a new letter (A–D) and each life stage will begin a new number (1–5).

```
ENTER  1 FOR LINEAR INTERPOLATION, 2 FOR NONLINEAR
```

If 2 is entered for nonlinear, the following prompt will appear.

```
ENTER  1 FOR LINEAR TAILS, 2 FOR NONLINEAR
```

Flow values in the flow-versus-time series that are smaller than lowest flows or greater than highest flows in the flow-versus-habitat relation are considered "tail" flows. Habitat values for these tail flows must be extrapolated. Indicate whether the extrapolation should be linear or nonlinear. The program will issue a warning because it could give negative or wildly irrational results for nonlinear extrapolation. Do not use this option unless you are prepared to handle this.

```
ENTER  1 FOR AVERAGE HABITAT AS MONTHLY HABITAT
       2 FOR MINIMUM HABITAT AS MONTHLY HABITAT
       3 FOR MINIMUM OF N-DAYS AS MONTHLY HABITAT
       4 FOR MEDIAN HABITAT AS MONTHLY HABITAT
```

Description of options to calculate monthly habitats:

1 = The monthly habitat value is the average of the daily habitats for the month.

2 = The monthly habitat value is the minimum of the daily habitats for the month.

3 = The monthly habitat value is the minimum n-day average habitat value for the month.

The habitat value calculated with this is determined by

$$HA\,(j) = \frac{1}{n}\left(\min\left[\sum_{i=1}^{n} HAD\,(j,i), \sum_{i=2}^{n+1} HAD\,(j,i), \sum_{i=3}^{n+2} HAD\,(j,i), \ldots, \sum_{i=m-n}^{m} HAD\,(j,i)\right]\right)$$

where

j = the index to the month,

i = the day,

m = the number of days in month j,

n = the number of days specified for an average,

HAD = the daily habitat, and

HA = the monthly habitat.

Use of a minimum n-day average makes the assumption that the fish can be crowded for short periods and cannot fill all the habitat during periods of excess habitat when those periods are relatively short.

4 = The monthly habitat value is the median habitat value for the month.

If 3 is selected, you will be prompted to enter

```
HOW MANY DAYS:
```

Enter the number of days needed to determine the minimum average. The program will average the flow for all *n* consecutive days for the month and use the minimum average for the monthly habitat value.

```
ENTER  0 NO PRINT OF DAILY VALUES
       1 FOR REPORT FORMAT OUTPUT OF DAILY VALUES
       2 FOR LOTUS FILE FORMAT OUTPUT OF DAILY VALUES
```

The program will begin computation. This computation might take anywhere from a few seconds to 15 min depending on the speed of your computer.

The two file formats available for the daily habitat values files (DAYFL) are shown in Fig. 6.6. Figure 6.7 contains sample output from the ZOUT file. Figure 6.8 contains the monthly habitat time series (ZMTS) file from HABTD.

Sample Daily Habitat Values File (DAYFL) in Report Format:

```
89/04/20.         SNOQUALMIE RIVER
13.52.35.         NEAR SNOQUALMIE FALLS, WA
               SPECIES: RAINBOW TROUT                          LIFE STAGE:    FRY
                Date       Daily Habitat

               MONTH: 10- YEAR: 70

                 1 -   18044.80  2 -   17418.40  3 -   16792.00  4 -   16513.60  5 -   15725.80
                 6 -   18601.20  7 -   19784.00  8 -   19789.00  9 -    7062.20 10 -    9419.80
                11 -   15270.80 12 -   14542.80 13 -   17627.60 14 -   19270.80 15 -   19780.40
                16 -   19786.40 17 -   19753.60 18 -   19789.00 19 -   18855.60 20 -   17627.60
                21 -   15052.40 22 -   15052.40 23 -    9963.00 24 -    9672.00 25 -   15489.20
                26 -   18474.00 27 -   19471.80 28 -   19781.00 29 -   19785.60 30 -   19788.20
                31 -   19717.20
```

Sample Daily Habitat Values File (DAYFL) in LOTUS 1-2-3 Format:

```
89/04/20.         SNOQUALMIE RIVER
13.56.24.         NEAR SNOQUALMIE FALLS, WA
               SPECIES: RAINBOW TROUT                          LIFE STAGE:    FRY
              "  Date           - Daily Habitat
              "10/ 1/70"             18044.80
              "10/ 2/70"             17418.40
              "10/ 3/70"             16792.00
              "10/ 4/70"             16513.60
              "10/ 5/70"             15725.80
              "10/ 6/70"             18601.20
              "10/ 7/70"             19784.00
              "10/ 8/70"             19789.00
              "10/ 9/70"              7062.20
              "10/10/70"              9419.80
```

Fig. 6.6. Sample daily habitat values file (DAYFL) formats from the HABTD program.

```
89/02/09.      SNOQUALMIE RIVER                                   PROGRAM - HABTD
15.37.35.      NEAR SNOQUALMIE FALLS, WA                                  PAGE  1

           HABITAT VS. STREAMFLOW FILE -

           RAINBOW TROUT
```

DISCHARGE	FRY	JUVENILE	ADULT
10.00	20570.00	8220.00	5780.00
100.00	15400.00	4770.00	3200.00
150.00	18880.00	7230.00	4890.00
200.00	19790.00	9360.00	6410.00
250.00	19780.00	11470.00	8020.00
300.00	19110.00	13140.00	9410.00
350.00	18050.00	14110.00	10400.00
400.00	16290.00	15850.00	12600.00
500.00	14470.00	16360.00	13660.00
600.00	11030.00	14610.00	13380.00
800.00	9090.00	12310.00	11740.00
1000.00	7410.00	9270.00	8880.00
1500.00	6940.00	8490.00	7620.00
2000.00	7210.00	8630.00	7810.00
4000.00	6660.00	9480.00	8510.00
6000.00	5740.00	9890.00	9670.00

```
89/02/09.      SNOQUALMIE RIVER                                   PROGRAM - HABTD
15.37.35.      NEAR SNOQUALMIE FALLS, WA                                  PAGE  2
                         HABITAT FACTORS FOR RAINBOW TROUT                 -   FRY
```

DISCHARGE	AREA	A	B	C	D
10.00	20570.00				
		0.00	0.00	-57.44	21144.45
100.00	15400.00				
		0.00	0.00	69.60	8440.00
150.00	18880.00				
		0.00	0.00	18.20	16150.00
200.00	19790.00				
		0.00	0.00	-0.20	19830.00
250.00	19780.00				
		0.00	0.00	-13.40	23130.00
300.00	19110.00				
		0.00	0.00	-21.20	25470.00
350.00	18050.00				
		0.00	0.00	-35.20	30370.00
400.00	16290.00				
		0.00	0.00	-18.20	23570.00
500.00	14470.00				
		0.00	0.00	-34.40	31670.00
600.00	11030.00				
		0.00	0.00	-9.70	16850.00
800.00	9090.00				
		0.00	0.00	-8.40	15810.00
1000.00	7410.00				
		0.00	0.00	-0.94	8350.00
1500.00	6940.00				
		0.00	0.00	0.54	6130.00
2000.00	7210.00				
		0.00	0.00	-0.28	7760.00
4000.00	6660.00				
		0.00	0.00	-0.46	8500.00
6000.00	5740.00				

```
HA = A*Q**3 + B*Q**2 + C*Q + D
```

> The following warning appeared on the screen when the HABTD program was running:
> "Warning—Daily streamflow data is out of bounds of habitat/flow relationship. Invalid results may occur.
> See ZOUT for more detail."

```
WARNING - DISCHARGE   7400.000 GREATER THAN HIGHEST FLOW IN Q - HA RELATIONSHIP
WARNING - DISCHARGE   6900.000 GREATER THAN HIGHEST FLOW IN Q - HA RELATIONSHIP
WARNING - DISCHARGE   6660.000 GREATER THAN HIGHEST FLOW IN Q - HA RELATIONSHIP
WARNING - DISCHARGE   6650.000 GREATER THAN HIGHEST FLOW IN Q - HA RELATIONSHIP
WARNING - DISCHARGE   7280.000 GREATER THAN HIGHEST FLOW IN Q - HA RELATIONSHIP
```

Fig. 6.7. Sample output (ZOUT file) from the HABTD program.

MEAN MONTHLY STREAMFLOW DATA -

H 12142000 47365412142440053530 33SW17110010 64.00 1130.00
N 12142000 N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.

	MONTH											
YEAR	1	2	3	4	5	6	7	8	9	10	11	12
1971	363.84	588.87	480.13	937.68	834.11	396.55	444.27	1053.77	875.37	717.16	176.84	208.37
1972	373.65	788.20	536.77	651.45	1125.00	1250.29	682.43	1169.74	997.77	732.74	181.10	369.23
1973	170.52	391.93	971.87	576.71	218.54	275.23	352.63	523.23	493.00	161.65	63.58	144.83
1974	430.87	574.30	805.23	1105.45	452.75	669.68	620.30	877.35	1338.43	724.52	262.65	92.27
1975	50.94	527.60	768.35	919.35	438.61	428.00	279.20	853.68	801.97	564.06	306.58	162.63
1976	518.32	961.57	1556.03	996.00	342.69	243.87	479.87	785.35	645.20	491.03	322.84	156.50
1977	153.39	387.73	485.19	500.16	324.82	332.26	604.90	535.10	438.83	141.94	140.94	261.73
1978	270.32	969.07	1205.23	450.00	365.46	382.90	388.20	524.03	397.57	179.16	189.90	452.27
1979	151.10	545.90	464.52	222.06	581.82	653.84	515.57	713.87	460.93	285.68	72.52	87.03
1980	194.87	134.73	1202.06	325.65	549.41	376.00	655.50	452.23	443.30	226.26	159.10	432.97
1981	138.84	879.90	1139.23	244.26	911.86	245.87	874.47	566.97	727.80	220.90	94.29	212.97
1982	526.13	380.47	580.77	822.19	1294.68	569.74	420.17	697.00	719.33	374.68	156.42	273.37

HABITAT TIME SERIES -

RAINBOW TROUT
FRY

	MONTH											
YEAR	1	2	3	4	5	6	7	8	9	10	11	12
1971	16894.	14585.	16598.	12035.	12444.	16865.	15501.	8019.	9006.	10400.	17841.	17452.
1972	16294.	12313.	15399.	15073.	11639.	9344.	12353.	8409.	8325.	12460.	18655.	15320.
1973	17872.	16138.	13202.	16229.	18966.	19033.	17418.	14164.	14600.	17977.	17492.	17434.
1974	15879.	14592.	10831.	12325.	15749.	13271.	11672.	10222.	7804.	10121.	18474.	17152.
1975	18218.	14871.	13755.	13843.	15871.	16687.	18945.	9960.	9786.	14472.	17169.	17229.
1976	14953.	11717.	10860.	11302.	17715.	18909.	14929.	10597.	12494.	14811.	18238.	17802.
1977	16681.	16269.	16253.	16897.	17474.	17980.	13293.	13607.	15855.	17876.	17495.	17694.
1978	17725.	11887.	12576.	16373.	17150.	16754.	16876.	13973.	16614.	18622.	17352.	16031.
1979	17986.	15351.	16165.	18184.	14082.	14780.	14224.	10697.	15320.	17188.	16979.	17094.
1980	17148.	17548.	11464.	17626.	14897.	17149.	12386.	15392.	15625.	18762.	16667.	16649.
1981	17381.	12436.	10624.	18758.	13237.	19253.	12931.	13102.	11700.	19105.	16670.	16783.
1982	15170.	16546.	14496.	14170.	12447.	15264.	16186.	10901.	10577.	16605.	17271.	16979.

AVERAGE OF DAILY HABITAT VALUES USED AS MONTHLY VALUE

Fig. 6.7. *Continued.*

```
CLASSA1
SNOQUALMIE RIVER
   FRY     RAINBOW TROUT
12142000     1971 1     16894    14585    16598    12035    12444    16865
12142000     1971 2     15501     8019     9006    10400    17841    17452
12142000     1972 1     16294    12313    15399    15073    11639     9344
12142000     1972 2     12353     8409     8325    12460    18655    15320
12142000     1973 1     17872    16138    13202    16229    18966    19033
12142000     1973 2     17418    14164    14600    17977    17492    17434
12142000     1974 1     15879    14592    10831    12325    15749    13271
12142000     1974 2     11672    10222     7804    10121    18474    17152
12142000     1975 1     18218    14871    13755    13843    15871    16687
12142000     1975 2     18945     9960     9786    14472    17169    17229
12142000     1976 1     14953    11717    10860    11302    17715    18909
12142000     1976 2     14929    10597    12494    14811    18238    17802
12142000     1977 1     16681    16269    16253    16897    17474    17980
12142000     1977 2     13293    13607    15855    17876    17495    17694
12142000     1978 1     17725    11887    12576    16373    17150    16754
12142000     1978 2     16876    13973    16614    18622    17352    16031
12142000     1979 1     17986    15351    16165    18184    14082    14780
12142000     1979 2     14224    10697    15320    17188    16979    17094
12142000     1980 1     17148    17548    11464    17626    14897    17149
12142000     1980 2     12386    15392    15625    18762    16667    16649
12142000     1981 1     17381    12436    10624    18758    13237    19253
12142000     1981 2     12931    13102    11700    19105    16670    16783
12142000     1982 1     15170    16546    14496    14170    12447    15264
12142000     1982 2     16186    10901    10577    16605    17271    16979
#EOR
CLASSA2
SNOQUALMIE RIVER
   JUVENIL RAINBOW TROUT
12142000     1971 1     11761    12041    11761    10643    12995    12959
12142000     1971 2     14707    10262    11720    13246     8165     8814
12142000     1972 1     10550    14077    13141    13486    11449    10875
12142000     1972 2     13863    10354    10751    13459     8464     8327
12142000     1973 1      7892    11082     9920    12329     9651    11976
12142000     1973 2     13516    14539    14240     7768     6166     8132
12142000     1974 1     10915    12589    12946     9843    13967    13730
12142000     1974 2     14539    12610     9849    13166    10751     6025
12142000     1975 1      6651    11219    13339    12126    13999    12949
12142000     1975 2     12067    12121    12469    12077     9752     7595
12142000     1976 1     11071    12068    11931    13269    12954    10707
12142000     1976 2     14130    12928    13853    13878    12009     7333
12142000     1977 1      7163    10057    12426    10209    11580    13281
12142000     1977 2     13429    14860    12536     6922     8272    10577
12142000     1978 1      9678    11459    11517    12766    12983    12148
12142000     1978 2     14068    14337    14229     8388     8384    13679
12142000     1979 1      7193    11703    12911     8654    11750    13549
12142000     1979 2     14021    13247    14295    10639     5824     5954
12142000     1980 1      8611     6556    11472    11455    12392    14310
12142000     1980 2     12998    14646    14608    10139     7218    10598
12142000     1981 1      6585    12299    11725    10522     9666    10815
12142000     1981 2     13315    14996    13070    10018     5650     8625
12142000     1982 1     11246    12809    13391    10829    12272    13275
12142000     1982 2     13115    13512    13179    13187     7071     8493
#EOR
```

Fig. 6.8. Sample monthly habitat time series (ZMTS) file from the HABTD program. Sample incomplete; terminated for brevity.

Chapter 7. Generation of the Time Series of Monthly Habitats

Introduction

The state of the art when doing an instream flow analysis is to do an analysis of monthly habitat values. Most of the time, the average monthly streamflow is transformed to monthly physical habitat from the relation between the physical habitat and streamflow determination using PHABSIM (Figs. 7.1 and 7.2).

The HABTD (see Chapter 6), HABTS, and HABNET programs are available to develop a monthly time series of habitats. The HABTS program calculates monthly habitat values at a site for multiple species and life stages. The HABNET program generates a networkwide monthly habitat time series. Habitat values may be temperature conditioned at the option of the user.

Calculating monthly habitat time series is the easy part; knowing what to do with the results is the more difficult part and will be partially addressed in Chapter 8. The programs described in Chapter 7 calculate the habitat area associated with the input time series of streamflow. The resulting habitat time series can then be graphed to illustrate the frequency of periods when habitat values seem to be limiting, or the results can be statistically tabulated to either summarize the probabilities of exceeding certain levels of habitat or integrate the habitat values over time.

Either analysis technique may be used when comparing one alternative water management scenario with another or with the baseline condition. In multiple streamflow scenarios, the habitat time series programs would need to be run repeatedly (once for each set of streamflow data) and each resulting habitat time series data file would need to be saved with a different name for subsequent comparison.

We usually assume that the habitat-versus-flow relation does not change from one alternative set of streamflows to another. However, *always* question that assumption. It could be that one alternative will result in channel change, another in changing water quality, another in periodicity changes due to migration blockages or temperature change. Simply running alternative flow scenarios without asking yourself about the physical or biological consequences is inappropriate.

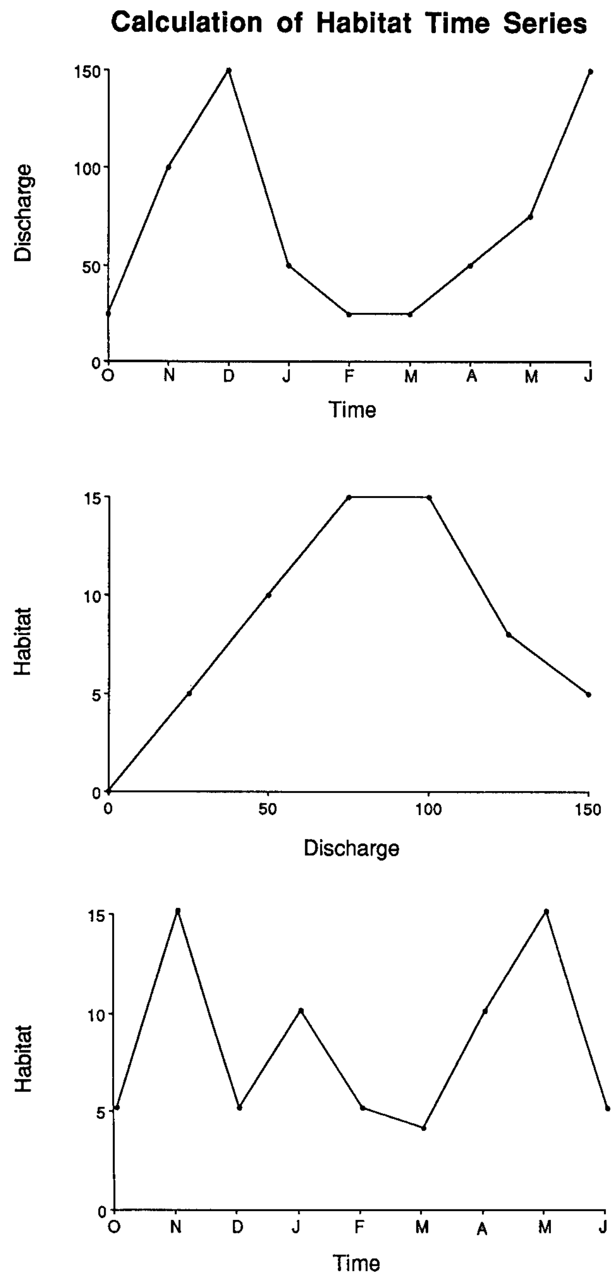


Fig. 7.1. Calculation of habitat time series.

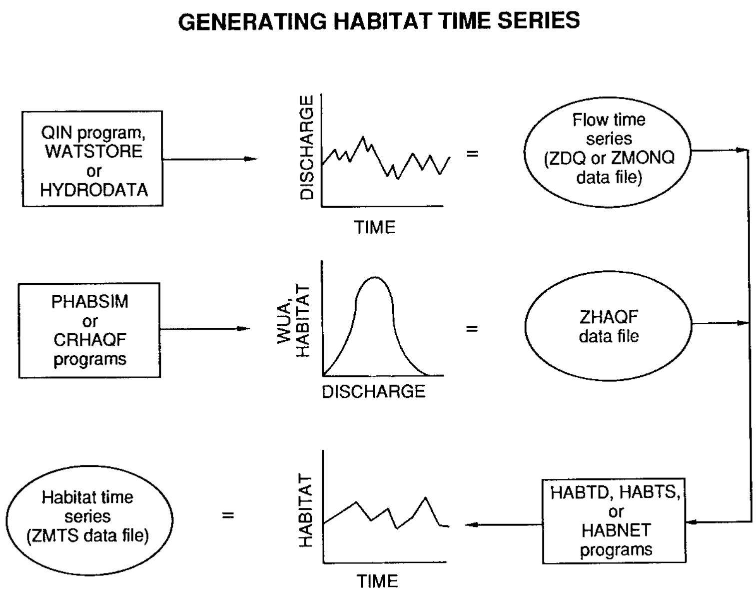


Fig. 7.2. Generating habitat time series.

Monthly Habitat Time Series Generation

Program Name	Batch/Procedure Filename	Function	Program Description
HABTS	RHABTS	Monthly habitat time series generation	Creates a monthly physical habitat time series file for multiple species and life stages. The program calculates monthly habitat values at the site, using linear or nonlinear interpolation, for each species, each life stage.

RHABTS, ZHAQF, ZMONQ, ZMTS, ZOUT

ZHAQF = Habitat-versus-flow file (input).

ZMONQ = Monthly streamflow file in USGS or NWDC format (input).

ZMTS = Monthly habitat time series file with multiple records in the same format as the ZMONQ file (output).

ZOUT = HABTS results (output).

Program Name	Batch/Procedure Filename	Function	Program Description
HABNET	RHABNET	Networkwide monthly habitat time series generation	Generates a networkwide monthly habitat time series. Habitat values may be temperature conditioned at the option of the user. **RHABNET, ZHABIN, ZMTS, ZMTSM, ZHAQFM, ZTEMP, ZTSI, ZOUT** **ZHABIN** = HABNET input file created by HABINN (input). **ZMTS** = Habitat time series data (output). Will be in the same format as ZMTSM. **ZMTSM** = Modified monthly flow time series in USGS or NWDC format (input). Can be a multirecord file. **ZHAQFM** = Modified habitat area-versus-flow file with month indicators and minimum habitat values (input). This file can be created by the HQFMON program. **ZTEMP** = Temperature time series data in USGS or NWDC format **or** a free-formatted file with parameters for a temperature-versus-flow relation (optional input). The free-formatted file can be created with the QTEM program or type INFOTQ for information on the format of the free-formatted file. **ZTSI** = Network temperature suitability criteria file *or* FISHCRV file with temperature suitability criteria (optional input). Type INFOTSI for information on the format of the network temperature suitability criteria file. **ZOUT** = HABNET results (output).

Creation of Input Files for the HABNET Program

Program Name	Batch/Procedure Filename	Function	Program Description
HABINN	**RHABINN**	HABNET options file creation	Builds a HABNET options file. **RHABINN, ZHABIN** **ZHABIN** = HABNET options file (output).
HQFMON	**RHQFMON**	HABNET ZHAQFM file creation	Adds month indicators and minimum habitat values to a habitat area-versus-streamflow file. **RHQFMON, ZHAQF, ZHAQFM** **ZHAQF** = Habitat area-versus-streamflow file (input). **ZHAQFM** = Habitat area-versus-streamflow file with month indicators and minimum habitat values (output). An extra title line and segment ID line can also be added if they were not previously entered with an editor.
QTEM	**RQTEM**	HABNET ZTEMP file creation	Generates a temperature versus flow equation file. **RQTEM, ZTEMP** **ZTEMP** = Free-formatted flow versus temperature equation file (output).

HABINN Program

Introduction

The HABINN program builds a HABNET options file. This file contains information on which river segments to process, which species and life stages to process, what period (both in years and months) to process, the segment lengths, and the format of the temperature suitability criteria file (ZTSI). With this information, comparisons may be made across both time and space for any biological requirement.

Figure 7.3 contains a sample HABNET input file created by the HABINN program. The file format for a HABINN file is included in Appendix A.

Running HABINN

RHABINN, ZHABIN

ZHABIN = HABNET options file (output).

```
ENTER TITLE LINE FOR HABNET INPUT FILE (80 CHAR MAX):
```

This title line will be written to the habitat time series file (ZMTS) and output file (ZOUT) from HABNET.

```
POUDRE RIVER TOTAL NETWORK ANALYSIS
TEMP FORMAT 1
ENGLISH UNITS
WY:KSQFT
FIRST YEAR OF DATA    1954
LAST YEAR OF DATA     1983
MONTHS               111111111111
1 SEG 1.5              8.0
1 SEG 1.4             38.0
1 SEG 1.1              6.3
1 SEG 2.2              4.9
1 SEG 3.3              5.1
1 SEG 4.1              1.0
1 SEG 4.2              6.3
**********
1 BROWN       ADULT
1 BROWN       JUVENILE
1 BROWN       FRY
1 BROWN       SPAWNING
1 RAINBOW     ADULT
1 RAINBOW     JUVENILE
1 RAINBOW     FRY
1 RAINBOW     SPAWNING
**********
```

Fig. 7.3. Sample input file for HABNET created by HABINN.

```
THE TEMPERATURE SUITABILITY FILE (ZTSI) MAY BE IN
EITHER NETWORK TEMPERATURE SUITABILITY FILE FORMAT
OR PHABSIM FISHCRV FILE FORMAT.

ENTER:  0 FOR NO TEMPERATURE SUITABILITY INDEX FILE
        1 FOR NETWORK TEMPERATURE SUITABILITY INDEX FILE
        2 FOR FISHCRV FILE
```

The QTEM program generates a network temperature suitability index file. A FISHCRV file is created by the PHABSIM program, GCURV.

```
THE HABNET PROGRAM ASSUMES THAT YOUR UNITS ARE EITHER
METRIC OR ENGLISH.
IF YOU SPECIFY METRIC, THE PROGRAM ASSUMES THAT THE
FLOW DATA IS IN CMS AND THE SEGMENT LENGTH IS IN
KILOMETERS.
IF YOU SPECIFY ENGLISH, THE PROGRAM ASSUMES THAT THE
FLOW DATA IS IN CFS AND THE SEGMENT LENGTH IS IN MILES.

ENTER:  0 FOR METRIC UNITS
        1 FOR ENGLISH UNITS
```

If English units are being used, the calculations will be in thousands of square feet (KSQFT). If metric units are being used, the calculations will be thousands of square meters (KSQM).

```
ENTER THE YEAR CODE FOR THE DATA (2 CHAR) IN CAPITAL LETTERS
        AY = AGRICULTURAL YEAR
        CY = CALENDAR YEAR
        WY = WATER YEAR
           = BLANK
```

> Note: The months should be in the same format for all input files (ZHABIN, ZMTSM, ZHAQFM, and ZTEMP)—that is, all in water years, calendar years, and so forth.

```
ENTER FIRST YEAR OF DATA TO BE INCLUDED IN PROCESSING:
ENTER LAST YEAR OF DATA TO BE INCLUDED IN PROCESSING:
```

If years entered here are out of range with the data in the gaging station flow file (ZMTSM file also used as input to HABNET), then the defaults are to use the first and last years of gaging station data from the ZMTSM file.

```
HABNET ALLOWS YOU TO INCLUDE ONLY THE MONTHS THAT ARE
LOGICAL FOR PROCESSING. A '1' INDICATES THAT THE
MONTH IS TO BE INCLUDED IN PROCESSING. A '0'
INDICATES THAT THE MONTH IS NOT TO BE INCLUDED.

ENTER 1 OR 0 FOR EACH MONTH [need 12 characters].

EXAMPLE:      110111100111
       :      100000000000
```

In this example, if the data is in water years, October would be the only month processed.

The processing of each month is determined from *both* the HABNET input file (ZHABIN) and the habitat-versus-flow file with month indicators (ZHAQFM). Both month indicators must be "on" to be processed. Some examples follow:

- If month indicator is 1 in ZHABIN and 1 in ZHAQFM, then that month *will* be processed for that species, life stage, and location.
- If month indicator is 1 in ZHABIN and 0 in ZHAQFM, that month *will not* be processed for that species, life stage, and location.
- If month indicator is 0 in ZHABIN and 1 in ZHAQFM, that month *will not* be processed for that species, life stage, and location.
- If month indicator is 0 in ZHABIN and 0 in ZHAQFM, that month *will not* be processed for that species, life stage, and location.

```
HABNET PROCESSES DATA BY SEGMENTS. SEGMENTS IN THE
INPUT FILE ARE DESIGNATED BY A SEGMENT ID (8 CHARACTERS).
CROSS SECTIONS AND CROSS SECTION ID'S MAY ALSO BE USED.
THE SEGMENT ID'S FOR THE DATA TO BE PROCESSED MUST
HAVE A MATCHING SEGMENT ID ON EACH OF THE DATA FILES.

ENTER SEGMENT ID (8 CHAR MAX) OR Q TO QUIT ENTERING
SEGMENT ID'S:
```

The segment ID numbers have to match exactly with the segment ID numbers read from the gaging station data file (ZMTSM), the habitat area-versus-streamflow file (ZHAQFM), and the temperature time series or temperature-versus-flow relation file (ZTEMP).

```
THIS SEGMENT ID WILL APPEAR ON YOUR INPUT FILE;
HOWEVER, YOU MAY WISH TO EXCLUDE THIS SEGMENT FROM
PROCESSING.

ENTER   1 TO INCLUDE THIS SEGMENT IN PROCESSING
        0 TO EXCLUDE THIS SEGMENT FROM PROCESSING.
```

At least one segment must be processed. The program will terminate with a fatal error if there are no segments.

```
ENTER THE SEGMENT LENGTH:
```

This downstream distance, measured in miles or kilometers, is the multiplier for the WUA. The downstream distance is the segment length for which one assumes that the PHABSIM hydraulics and preference criteria apply. Note that if one scenario calls for a reservoir that will inundate part or all of a biological segment, you must account for that inundation by adjusting the segment length. Also, this distance may be adjusted to account for a life stage weight.

Enter the information (segment ID, whether or not to include the segment in the processing, and the segment length) for each segment in the network.

When Q is entered to quit entering segments, the following prompts will appear:

```
SPECIES AND LIFE STAGE FOR HABNET PROCESSING:
ENTER SPECIES (10 CHAR MAX), OR 'Q' TO QUIT
ENTERING SPECIES:
ENTER LIFE STAGE (10 CHARACTERS MAXIMUM):

THIS LIFE STAGE WILL BE INCLUDED ON YOUR INPUT FILE;
HOWEVER, YOU MAY WISH TO EXCLUDE THIS LIFE STAGE FROM
PROCESSING.

ENTER   1 TO INCLUDE THIS LIFE STAGE IN PROCESSING
        0 TO EXCLUDE THIS LIFE STAGE FROM PROCESSING
```

When Q is entered to quit entering species and life stages, the HABNET input file (Fig. 7.3, sample) will be created.

HABNET Program

Introduction

The HABNET program generates a networkwide monthly habitat time series. Habitat values may be temperature conditioned at the option of the user.

Input to the HABNET program is: (1) an options file created by the HABINN program (ZHABIN file); (2) a habitat area-versus-flow file with month indicators and minimum habitat values created by the HQFMON program (ZHAQFM file); (3) a gaging station flow data file in USGS or NWDC format (ZMTSM file); (4) a temperature data file in USGS or NWDC format *or* a free-formatted file with empirically derived parameters for a temperature-versus-flow relation (ZTEMP file); and (5) a temperature criteria file in FISHCRV format *or* a free-formatted file with temperature suitability criteria (ZTSI file). Figure 7.4 diagrams the flow of information through the HABNET program.

Flows in the gaging station flow data file (ZMTSM) are matched with the habitat-versus-flow relation with month indicators and minimum habitat values (ZHAQFM file) for one or more life stages at one or more geographic locations. It will optionally modify that habitat value with temperatures provided to produce a networkwide habitat time series for each unique life stage. The temperature-induced habitat modification is accomplished with the use of a temperature-versus-suitability index relation for each life stage. If used, the suitability for temperature (between 0 and 1) is simply multiplied by the normal WUA value. Though calculations are independent of any given time step, the output files do assume a monthly format.

Units, with the exception of segment length, are arbitrary and it is up to the user to make sure that they match between files. You will be safe if the weighted usable area (WUA) data is in ft^2/1,000 ft per cfs and flows are in cfs. If temperature values are given in °F, then the temperature suitability index curve must be in °F.

The usable area for each life stage is calculated through time and space. At each segment, the routine determines which months are applicable. Any life stage may be in different geographic locations at different times of the year to account for migration or movement. Applicability of each month is determined both from the HABNET input file (ZHABIN) and the habitat-versus-flow file with month indicators (ZHAQFM). Both month indicators must be "on" to be applicable. If applicable, the flow is determined and the corresponding WUA is interpolated from the habitat-versus-flow relation. If the flow is less than the lowest flow in the curve, or greater than the highest flow, a message is printed and the WUA is set to zero.

Next, the corresponding temperature value is retrieved either from reading it directly from the temperature time series data or calculated using a temperature-versus-flow relation with empirically derived parameters provided in the ZTEMP file. The suitability index (SI) value is interpolated from the SI curve taken from the ZTSI file in either FISHCRV or network temperature suitability file format. Again, if the temperature falls below the lowest point in the SI curve or above the highest point, a message is printed and the SI value is set to zero. The SI value is multiplied by the WUA and the segment length to give total habitat. If there are no SI and temperature data supplied for a particular life stage, then this process does not occur. Instead, the WUA is multiplied by the segment length to give total habitat. If, however, temperature data have been only partially provided for a life stage, then the processing of the life stage is skipped and no time series data are produced. This is to ensure that data will not be produced for one life stage containing both temperature-conditioned and nontemperature-conditioned habitat values.

This process repeats for all applicable segments. Any segment for which there is no weighted usable area-versus-flow curve for a life stage is ignored. The total area for all segments for each life stage is added together to complete the networkwide approach. Finally, each year's worth of data is written to the habitat time series data file (ZMTS). Inapplicable months are assigned a value of 1.E-99 to be distinguished from zero. Note that if a life stage is found at one segment during October, but not at another segment in that same month, only applicable segment–month combinations will be summed.

Current program limits are listed here; however, most limits may be changed by altering the parameter statements in the source code and recompiling.

Maximum number of segments or gaging stations	50
Maximum number of life stages	10
Maximum number of points in HA-versus-Q curve	30
Maximum number of years	None
Maximum number of time steps per year	12
Minimum number of time steps per year	12
Maximum number of points in a T-SI curve	15

Notes regarding the HABNET program:

1. When setting up your gaging station data set, you must remember to account for the physical habitat sites in the network description. General guidelines would call for establishing a segment wherever there is likely to be a change in flow of >10% through a habitat site. In this way, accurate translation of flow to habitat value may be retained.

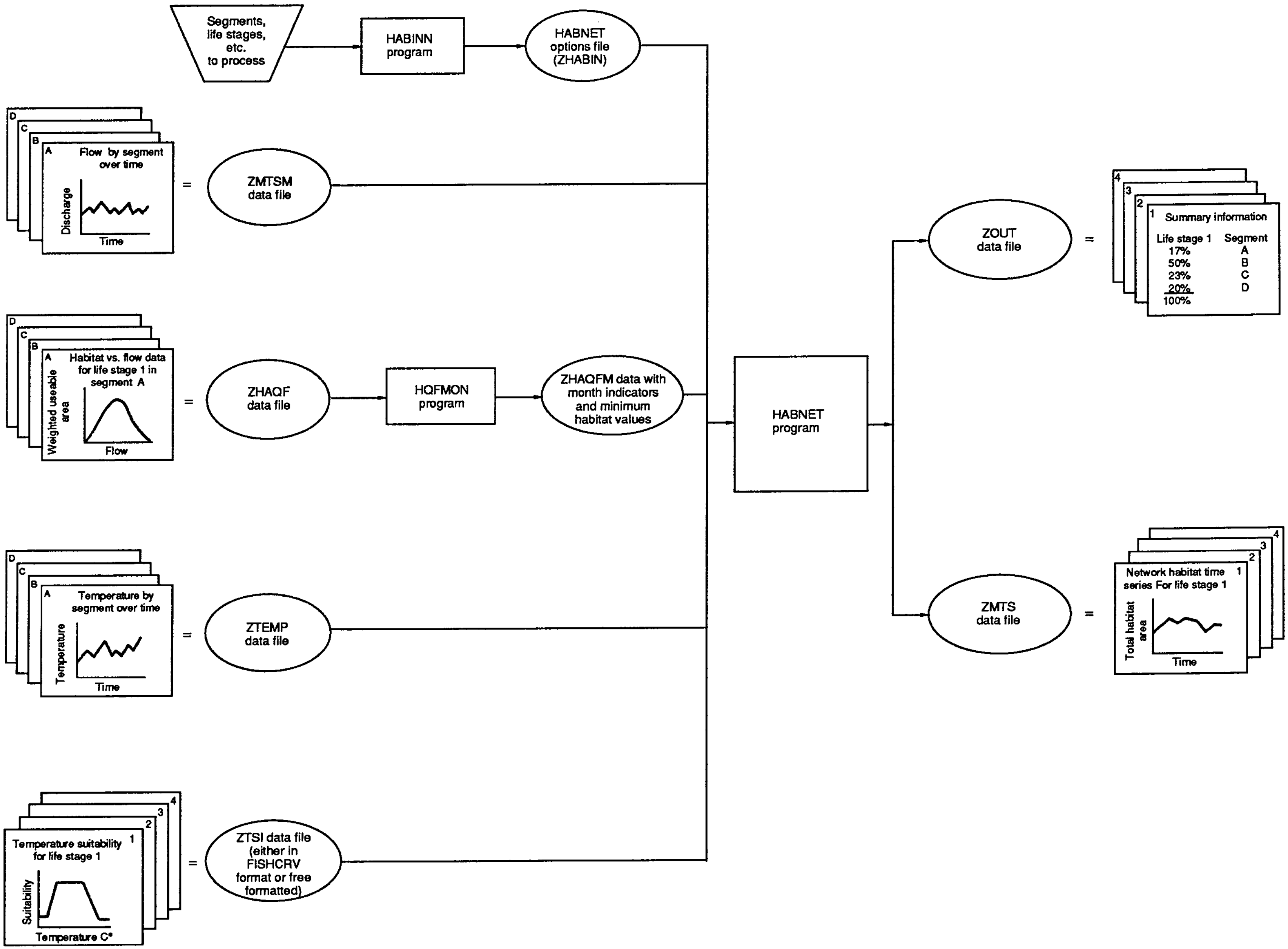


Fig. 7.4. Flow of information through the HABNET program.

2. Aside from assembling all of the habitat area- versus-streamflow data files (known as ZHAQF's in PHABSIM) into a single file, there remains at least one important task: The upper and lower bounds of each curve should be examined for their ability to handle the extremes of yearly flows likely to be encountered. HABNET does *no* curve extrapolation (as do some other TSLIB routines). If a flow is encountered outside the bounds of a life stage's curve, the habitat value is set to zero. A warning message is issued, but it is the user's responsibility to provide reasonable extrapolations or accept the consequences. This approach is more prudent than extrapolation, because pure mathematical extrapolation is not often hydrologically or biologically acceptable.
3. We have made much use of TSLIB plotting and duration analysis programs to continue the analysis of the results of HABNET. Typically, you would use GET1 to extract single life stages as records from the habitat time series file (ZMTS) to be used as input to programs such as LPTDUR and LPTTSN. Links to the effective habitat time series programs should be performed in the same way.

The HABNET program is a member of a family of programs in the network habitat analysis family. This group includes:

LNKQ2T — HYDROSS to temperature model,

LNKT2H — Temperature to habitat model,

LNKQ2H — HYDROSS to habitat model, and

LNKT2TS — Temperature to time series program.

Refer to Bartholow and Waddle (1986) for documentation on the other programs. (Note: The HABNET program replaces the LNKG2H program in Bartholow and Waddle 1986.) See also the PHABSIM, HYDROSS, and temperature model documentation.

Running HABNET

RHABNET, ZHABIN, ZMTS, ZMTSM, ZHAQFM, ZTEMP, ZTSI, ZOUT

ZHABIN = HABNET input file created by HABINN (input).

ZMTS = Habitat time series data (output). Will be in same format as ZMTSM.

ZMTSM = Modified monthly flow time series in USGS or NWDC format (input). Can be a multirecord file.

ZHAQFM = Modified habitat area-versus-flow file with month indicators and minimum habitat values (input). This file can be created by the HQFMON program.

ZTEMP = Temperature time series data in USGS or NWDC format *or* a free-formatted file with parameters for a temperature-versus-flow relation (optional input). The free-formatted file can be created with the QTEM program or type INFOTQ for information on the format of the free-formatted file.

ZTSI = Network temperature suitability criteria file *or* FISHCRV file with temperature suitability criteria (optional input). Type INFOTSI for information on the format of the network temperature suitability criteria file.

ZOUT = HABNET results (output).

The following is information on the format for the modified monthly flow time series file (ZMTSM) and the temperature suitability criteria file. The ZHABIN file is created by the HABINN program, the modified habitat area-versus-flow (ZHAQFM) file is created by the HQFMON program, and the ZTEMP file is either in USGS or NWDC format *or* is a free-formatted file created by the QTEM program. Refer to the individual program documentation for information on these files.

ZMTSM. This file is a standard monthly time series (ZMTS) file with the exception of the "DITTO" option and one title line before each gaging station or segment. These changes can be made with an editor. The ZMTSM file contains monthly flow data for gaging stations or segments. It is organized by gaging stations or segments and then by year and months within stations or segments. Appendix A contains a sample ZMTSM file and the file format.

ZTSI. ZTSI is a network temperature suitability criteria file *or* FISHCRV file with temperature criteria (optional input). Type INFOTSI for information on the free-formatted network temperature suitability criteria file. The FISHCRV file is created with the GCURV Program in PHABSIM. Appendix A contains a sample ZTSI file in free-formatted network temperature suitability criteria format and the file format.

There are two output files: the HABNET results (ZOUT) and the habitat time series file (ZMTS).

The ZOUT file contains a complete description of how the program runs, the sequence of events, warning and fatal error messages, and the summary report containing life stage statistics. Study this output file carefully—it

will be an immense help in ensuring that you have set up your data files correctly. It will also be invaluable as a record of what you did to accomplish a certain option, along with the date and time of the run. Sample ZOUT output is presented in Fig. 7.5.

```
************************************************
*      TIME SERIES LIBRARY PROGRAMS            *
*      AQUATIC SYSTEMS BRANCH, USFWS           *
*      VERSION 2.1 FEBRUARY, 1990              *
*      RUN DATE 90/05/22.  TIME 11.37.12.      *
************************************************

      HH    HH      AAA      BBBBBB    N     NN    EEEEEEE  TTTTTTTT
      HH    HH     AA AA     BB    BB  NN    NN    EE          TT
      HH    HH    AA   AA    BB    BB  NNN   NN    EE          TT
      HHHHHHH     AAAAAAA    BBBBBB    NN N NN     EEEEEE      TT
      HH    HH    AA   AA    BB    BB  NN   NNN    EE          TT
      HH    HH    AA   AA    BB    BB  NN    NN    EE          TT
      HH    HH    AA   AA    BBBBBB    NN     N    EEEEEEE     TT

        PROGRAM HABNET   VERSION NUMBER 2.0
        LAST MODIFIED MAY, 1990.

FILES USED IN PROCESSING HABNET RUN:
habin.dat                    = HABNET INPUT FILE
habnet.mts                   = MONTHLY HABITAT TIME SERIES FILE
mtsm.dat                     = MODIFIED MONTHLY FLOW TIME SERIES FILE
haqfm.dat                    = MODIFIED HABITAT-VS-FLOW FILE
templ.dat                    = TEMPERATURE DATA FILE
tsi.dat                      = TEMPERATURE SUITABILITY INDEX FILE
habnet.out                   = HABNET RESULTS

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
PROCESSING MONTHLY FLOW FILE: mtsm.dat

NETWORK GAGING STATION DATA CACHE LA POUDRE - USGS FORMAT
MEAN MONTHLY FLOWS (CFS)
FROM YEARS 1954 TO 1983

THE MONTHLY FLOW FILE CONTAINS THE FOLLOWING SEGMENTS:
SEGMENT#   SEGMENT TITLE / SEGMENT ID
________________________________________

    1 POUDRE RIVER SEGMENT 1 SITE 5 FLOWS (NOTE: SAME FLOW THRU 1)
      SEGMENT ID: SEG 1.5
    2 POUDRE RIVER SEGMENT 1 SITE 4 FLOWS (NOTE: FLOWS SAME AS 1.5)
      SEGMENT ID: SEG 1.4

***  SEGMENT  2 IS A DITTO SEGMENT, COPIED FROM SEGMENT: SEG 1.5

    3 POUDRE RIVER SEGMENT 1 SITE 1 FLOWS (NOTE: FLOWS FROM 2.2)
      SEGMENT ID: SEG 1.1

    4 POUDRE RIVER SEGMENT 2 SITE 2 FLOWS
      SEGMENT ID: SEG 2.2

***  SEGMENT  4 IS A DITTO SEGMENT, COPIED FROM SEGMENT: SEG 1.1

    5 POUDRE RIVER SEGMENT 3 SITE 3 FLOWS
      SEGMENT ID: SEG 3.3

    6 POUDRE RIVER SEGMENT 4 SITE 1 (NORTH FORK) FLOWS
      SEGMENT ID: SEG 4.1

    7 POUDRE RIVER SEGMENT 4 SITE 2 FLOWS (NOTE: SAME AS 4.1)
      SEGMENT ID: SEG 4.2

***  SEGMENT  7 IS A DITTO SEGMENT, COPIED FROM SEGMENT: SEG 4.1

END OF PROCESSING MONTHLY FLOW DATA FILE: mtsm.dat
```

Fig. 7.5. Sample output from the HABNET program.

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
PROCESSING SPECIES/LIFE STAGE Q-WUA DATA FILE: haqfm.dat

SEGMENT#     SEGMENT TITLE
  SEGMENT ID
 LIFE STAGE# AND NAME   VALID MONTHS   MINIMUM HABITAT VALUE   # OF POINTS
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   1 BROWN     ADULT      111111111111       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   2 BROWN     JUVENILE   111111111111       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   3 BROWN     FRY        000000011110       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   4 BROWN     SPAWNING   110000000000       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   5 RAINBOW   ADULT      111111111111       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   6 RAINBOW   JUVENILE   111111111111       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   7 RAINBOW   FRY        000000001110       0.000  13 POINTS

  1 POUDRE RIVER SEGMENT 1 SITE 5
    SEGMENT ID: SEG 1.5
   8 RAINBOW   SPAWNING   000000110000       0.000  13 POINTS

  2 POUDRE RIVER SEGMENT 1 SITE 4
    SEGMENT ID: SEG 1.4
   1 BROWN     ADULT      111111111111       0.000  13 POINTS

  2 POUDRE RIVER SEGMENT 1 SITE 4
    SEGMENT ID: SEG 1.4
   2 BROWN     JUVENILE   111111111111       0.000  13 POINTS

  2 POUDRE RIVER SEGMENT 1 SITE 4
    SEGMENT ID: SEG 1.4
   3 BROWN     FRY        000000011110       0.000  13 POINTS
  2 POUDRE RIVER SEGMENT 1 SITE 4
    SEGMENT ID: SEG 1.4
   4 BROWN     SPAWNING   110000000000       0.000  13 POINTS
```

Sections of sample output deleted here for brevity.

```
END OF PROCESSING SPECIES/LIFE STAGE Q-WUA DATA FILE: haqfm.dat
YOU HAVE  56 ENTRIES AND   8 UNIQUE LIFE STAGE(S).

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
PROCESSING TEMPERATURE DATA FILE: temp1.dat

NETWORK TEMPERATURE DATA CACHE LA POUDRE - USGS FORMAT
MEAN MONTHLY TEMPERATURE (DEGREES F)
FROM YEARS 1954 TO 1983

 THE TEMPERATURE DATA OUTPUT CONTAINS THE FOLLOWING NODES:
SEGMENT#  SEGMENT TITLE / SEGMENT ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    1 POUDRE RIVER SEGMENT 1 SITE 5
      SEGMENT ID: SEG 1.5

    2 POUDRE RIVER SEGMENT 1 SITE 4
      SEGMENT ID: SEG 1.4
```

Fig. 7.5. *Continued.*

```
***  SEGMENT  2 IS A DITTO SEGMENT, COPIED FROM SEGMENT: SEG 1.5

    3 POUDRE RIVER SEGMENT 1 SITE 1
      SEGMENT ID: SEG 1.1

    4 POUDRE RIVER SEGMENT 2 SITE 2
      SEGMENT ID: SEG 2.2

    5 POUDRE RIVER SEGMENT 3 SITE 3
      SEGMENT ID: SEG 3.3

    6 POUDRE RIVER SEGMENT 4 SITE 1 (NORTH FORK)
      SEGMENT ID: SEG 4.1

    7 POUDRE RIVER SEGMENT 4 SITE 2 FLOWS (NOTE: SAME AS SEGMENT 4 SITE 1)
      SEGMENT ID: SEG 4.2

***  SEGMENT  7 IS A DITTO SEGMENT, COPIED FROM SEGMENT: SEG 4.1

END OF PROCESSING TEMPERATURE DATA FILE: temp1.dat

 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 PROCESSING YOUR HABNET INPUT FILE: habin.dat

     POUDRE RIVER TOTAL NETWORK ANALYSIS

      UNITS = WY:KSQFT

     FIRST YEAR = 1954
     LAST YEAR = 1983

 FINISHED VERIFYING INCLUSIVE YEARS FROM HABNET INPUT, FLOW, AND TEMPERATURE
 DATA FILES. YOUR TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE
 PRODUCED FOR YEARS 1954 THROUGH 1983

 TEMPERATURE CRITERIA DATA (IF PRESENT) IS IN FISHCRV FILE FORMAT.

     MONTHS = 111111111111

    NODES LIST

  1 POUDRE RIVER SEGMENT 1 SITE 5 FLOWS (NOTE: SAME FLOW THRU 1)          SEGMENT ID: SEG 1.5
REACH LENGTH:      8.000

  2 POUDRE RIVER SEGMENT 1 SITE 4 FLOWS (NOTE: FLOWS SAME AS 1.5)         SEGMENT ID: SEG 1.4
REACH LENGTH:     38.000

  3 POUDRE RIVER SEGMENT 1 SITE 1 FLOWS (NOTE: FLOWS FROM 2.2)            SEGMENT ID: SEG 1.1
REACH LENGTH:      6.300

  4 POUDRE RIVER SEGMENT 2 SITE 2 FLOWS                                   SEGMENT ID: SEG 2.2
REACH LENGTH:      4.900

  5 POUDRE RIVER SEGMENT 3 SITE 3 FLOWS                                   SEGMENT ID: SEG 3.3
REACH LENGTH:      5.100

  6 POUDRE RIVER SEGMENT 4 SITE 1 (NORTH FORK) FLOWS                      SEGMENT ID: SEG 4.1
REACH LENGTH:      1.000

  7 POUDRE RIVER SEGMENT 4 SITE 2 FLOWS (NOTE: SAME AS 4.1)               SEGMENT ID: SEG 4.2
REACH LENGTH:      6.300

    LIFE STAGES LIST

  1 BROWN     ADULT
  2 BROWN     JUVENILE
  3 BROWN     FRY
  4 BROWN     SPAWNING
  5 RAINBOW   ADULT
  6 RAINBOW   JUVENILE
  7 RAINBOW   FRY
  8 RAINBOW   SPAWNING

 END OF PROCESSING HABNET INPUT FILE: habin.dat
```

Fig. 7.5. *Continued.*

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
PROCESSING SPECIES/LIFE STAGE TEMPERATURE-SI DATA FILE: tsi.dat
TEMPERATURE - SUITABILITY INDEX FILE FOR POUDRE RIVER.  DATA FROM RALEIGH

THE FOLLOWING LIFE STAGES WERE FOUND ON YOUR
TEMPERATURE SUITABILITY INDEX FILE:

    1 BROWN     ADULT          AVG      0.00 DEG HAS 7 DATA POINTS.
    2 BROWN     JUVENILE       AVG      0.00 DEG HAS 6 DATA POINTS.
    3 BROWN     FRY            AVG      0.00 DEG HAS 6 DATA POINTS.
    4 BROWN     SPAWNING       AVG      0.00 DEG HAS 6 DATA POINTS.
    5 RAINBOW   ADULT          AVG      0.00 DEG HAS 6 DATA POINTS.
    6 RAINBOW   JUVENILE       AVG      0.00 DEG HAS 6 DATA POINTS.
    7 RAINBOW   FRY            AVG      0.00 DEG HAS 9 DATA POINTS.
    8 RAINBOW   SPAWNING       AVG      0.00 DEG HAS 6 DATA POINTS.

END OF READING SPECIES/LIFE STAGE TEMPERATURE-SI DATA FILE: tsi.dat
YOU HAVE  8 LIFE STAGES REPRESENTED.

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
BEGINNING TO GENERATE HABITAT TIME SERIES FILE: habnet.mts
    90/05/22. 11.37.12.
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

  SPECIES#  SPECIES  LIFESTAGE       RECORD NAME

    1       BROWN     ADULT       =  BROWADU

FOR SPECIES/LIFE STAGE: BROWN     ADULT
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.

    2       BROWN     JUVENILE    =  BROWJUV

FOR SPECIES/LIFE STAGE: BROWN     JUVENILE
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.

    3       BROWN     FRY         =  BROWFRY

FOR SPECIES/LIFE STAGE: BROWN     FRY
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.

    4       BROWN     SPAWNING    =  BROWSPA

FOR SPECIES/LIFE STAGE: BROWN     SPAWNING
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.

    5       RAINBOW   ADULT       =  RAINADU

FOR SPECIES/LIFE STAGE: RAINBOW   ADULT
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.

    6       RAIN      JUVENILE    =  RAINJUV

FOR SPECIES/LIFE STAGE: RAINBOW   JUVENILE
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.
    7       RAINBOW   FRY         =  RAINFRY

FOR SPECIES/LIFE STAGE: RAINBOW   FRY
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.

    8       RAINBOW   SPAWNING    =  RAINSPA

FOR SPECIES/LIFE STAGE: RAINBOW   SPAWNING
TEMPERATURE CONDITIONED HABITAT TIME SERIES DATA WILL BE PRODUCED.


END OF HABITAT TIME SERIES GENERATION
DATA IS ON FILE: habnet.out

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
BEGINNING THE REPORT SECTION

=============================================================================
    1 BROWN     ADULT
```

Fig. 7.5. *Continued.*

```
         MINIMUM AREA ENCOUNTERED =      237.6778 IN YEAR 1967 MONTH  4
        AVERAGE AREA =      2064. KSQFT   PER MONTH
         MAXIMUM AREA ENCOUNTERED =     4546.9434 IN YEAR 1977 MONTH 10
SEGMENT  PERCENT  DESCRIPTION
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    1  10.30     POUDRE RIVER SEGMENT 1 SITE 5 FLOWS (NOTE: SAME FLOW THRU 1)
                  SEGMENT ID: SEG 1.5
    2  40.26     POUDRE RIVER SEGMENT 1 SITE 4 FLOWS (NOTE: FLOWS SAME AS 1.5)
                  SEGMENT ID: SEG 1.4
    3  14.36     POUDRE RIVER SEGMENT 1 SITE 1 FLOWS (NOTE: FLOWS FROM 2.2)
                  SEGMENT ID: SEG 1.1
    4   7.74     POUDRE RIVER SEGMENT 2 SITE 2 FLOWS
                  SEGMENT ID: SEG 2.2
    5  16.20     POUDRE RIVER SEGMENT 3 SITE 3 FLOWS
                  SEGMENT ID: SEG 3.3
    6   1.07     POUDRE RIVER SEGMENT 4 SITE 1 (NORTH FORK) FLOWS
                  SEGMENT ID: SEG 4.1
    7  10.09     POUDRE RIVER SEGMENT 4 SITE 2 FLOWS (NOTE: SAME AS 4.1)
                  SEGMENT ID: SEG 4.2
       -----
       100%

==============================================================================
   2 BROWN     JUVENILE
         MINIMUM AREA ENCOUNTERED =      507.3422 IN YEAR 1967 MONTH  4
        AVERAGE AREA =      3479. KSQFT   PER MONTH
         MAXIMUM AREA ENCOUNTERED =     6688.0308 IN YEAR 1954 MONTH 12
SEGMENT  PERCENT  DESCRIPTION
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

    1  13.14     POUDRE RIVER SEGMENT 1 SITE 5 FLOWS (NOTE: SAME FLOW THRU 1)
                  SEGMENT ID: SEG 1.5
    2  43.26     POUDRE RIVER SEGMENT 1 SITE 4 FLOWS (NOTE: FLOWS SAME AS 1.5)
                  SEGMENT ID: SEG 1.4
    3  14.78     POUDRE RIVER SEGMENT 1 SITE 1 FLOWS (NOTE: FLOWS FROM 2.2)
                  SEGMENT ID: SEG 1.1
    4   7.94     POUDRE RIVER SEGMENT 2 SITE 2 FLOWS
                  SEGMENT ID: SEG 2.2
    5  12.46     POUDRE RIVER SEGMENT 3 SITE 3 FLOWS
                  SEGMENT ID: SEG 3.3
    6   0.95     POUDRE RIVER SEGMENT 4 SITE 1 (NORTH FORK) FLOWS
                  SEGMENT ID: SEG 4.1
    7   7.46     POUDRE RIVER SEGMENT 4 SITE 2 FLOWS (NOTE: SAME AS 4.1)
                  SEGMENT ID: SEG 4.2
        -----
       100%

==============================================================================
```

Sections of sample output deleted here for brevity.

Fig. 7.5. *Continued.*

Past the run summary, the report section should be of particular significance. For each species and life stage, this section lists

1. Life stage name,
2. Minimum area encountered,
3. When minimum occurred (if more than one time, only first one is reported),
4. Average area encountered,
5. Maximum area encountered,
6. When maximum is encountered (if more than time, only first one is reported), and
7. Percentage of total area contributed by each segment.

The ZMTS file contains habitat time series data. This file will be in the same format (USGS or NWDC) as the ZMTSM file used as input. The file is arranged one life stage per record, with record titles composed of the first four characters of the species name and the first three characters of the life stage name. It may be convenient to pull one record at a time from this file by using the program GET1. Sample output is presented in Fig. 7.6.

Unlike a standard USGS or NWDC time series file, this file's station descriptor says SUM because the habitat values have been aggregated over a network and no single station identifier is relevant. The title of the habitat

```
BROWADU
POUDRE RIVER TOTAL NETWORK ANALYSIS
BROWN      ADULT      UNITS = WY:KSQFT       90/05/22. 11.37.12.
 SUM           1 1954  1   1803    1042 810.91 685.06 655.08 753.52    WY:KSQFT
 SUM           1 1954  2   2428    2663   2912   3821   3533   3991    WY:KSQFT
 SUM           1 1955  1   2297 930.00 370.86 411.86 443.23 575.25    WY:KSQFT
 SUM           1 1955  2 931.54    2703   2703   3499   4063   3726    WY:KSQFT
 SUM           1 1956  1   2411    1063 743.71 542.45 505.56   1019    WY:KSQFT
 SUM           1 1956  2   2066    2306   2693   3812   4280   3629    WY:KSQFT
 SUM           1 1957  1   1673 777.99 528.00 425.15 509.18 713.84    WY:KSQFT
 SUM           1 1957  2   1825    3112   2181   2713   3493   3445    WY:KSQFT
 SUM           1 1958  1   2612    1197 893.19 652.27 781.32   1278    WY:KSQFT
 SUM           1 1958  2   2478    2044   2547   3892   4262   3745    WY:KSQFT
 SUM           1 1959  1   2684 952.22 552.57 446.90 846.58   1425    WY:KSQFT
 SUM           1 1959  2   2304    2890   2528   3268   3773   3414    WY:KSQFT
 SUM           1 1960  1   2219    1743 626.93 449.00 589.34   1378    WY:KSQFT
 SUM           1 1960  2   2936    2780   2743   3384   4176   3794    WY:KSQFT
 SUM           1 1961  1   2190 875.02 495.94 629.32 579.19 817.74    WY:KSQFT
 SUM           1 1961  2   2189    2525   2270   3726   3470   3844    WY:KSQFT
 SUM           1 1962  1   3165    1972   1281   1130   1336   1760    WY:KSQFT
 SUM           1 1962  2   2937    2324   2497   3054   3567   3725    WY:KSQFT
 SUM           1 1963  1   2582    1003 671.50 491.88 608.88 540.46    WY:KSQFT
 SUM           1 1963  2   2495    2721   3027   3887   4019   3711    WY:KSQFT
 SUM           1 1964  1   1932    1082 409.66 303.81 390.17 895.55    WY:KSQFT
 SUM           1 1964  2   1671    2873   2951   3302   3953   3794    WY:KSQFT
 SUM           1 1965  1   2269 694.20 357.36 303.81 421.23 544.91    WY:KSQFT
 SUM           1 1965  2   1991    2997   2199   3124   3417   3901    WY:KSQFT
 #EOR
BROWJUV
POUDRE RIVER TOTAL NETWORK ANALYSIS
BROWN      JUVENILE   UNITS = WY:KSQFT       90/05/22. 11.37.12.
 SUM           2 1954  1   3624    2210   1678   1434   1341   1439    WY:KSQFT
 SUM           2 1954  2   4781    4461   4131   5257   5317   6688    WY:KSQFT
 SUM           2 1955  1   4841    1971 787.35 910.79 913.92   1136    WY:KSQFT
 SUM           2 1955  2   1936    4605   3459   4696   5677   6147    WY:KSQFT
 SUM           2 1956  1   4698    2411   1676   1209   1134   2167    WY:KSQFT
 SUM           2 1956  2   4261    3530   3405   5078   6089   6223    WY:KSQFT
 SUM           2 1957  1   3603    1727   1173 939.58   1124   1537    WY:KSQFT
 SUM           2 1957  2   3749    5541   2741   3269   4759   5481    WY:KSQFT
 SUM           2 1958  1   5112    2636   1889   1393   1668   2569    WY:KSQFT
 SUM           2 1958  2   4676    3415   3295   5161   6030   6280    WY:KSQFT
 SUM           2 1959  1   5378    2047   1189 932.38   1783   2850    WY:KSQFT
 SUM           2 1959  2   4295    5051   3233   4303   5298   5802    WY:KSQFT
 SUM           2 1960  1   4679    3631   1359 951.38   1202   2886    WY:KSQFT
 SUM           2 1960  2   5883    4480   3501   4406   5936   6272    WY:KSQFT
 SUM           2 1961  1   4454    1955   1104   1333   1243   1829    WY:KSQFT
 SUM           2 1961  2   4030    4499   2898   5007   4958   6226    WY:KSQFT
 SUM           2 1962  1   6115    4079   2784   2493   2857   3660    WY:KSQFT
 SUM           2 1962  2   5655    3682   3238   3906   5017   6108    WY:KSQFT
 SUM           2 1963  1   5026    2071   1370 972.71   1239   1072    WY:KSQFT
 SUM           2 1963  2   4851    4488   4113   5268   5655   6134    WY:KSQFT
 SUM           2 1964  1   4095    2375 900.92 669.03 832.75   1810    WY:KSQFT
 SUM           2 1964  2   3323    4663   3826   4298   5654   6409    WY:KSQFT
 SUM           2 1965  1   4427    1500 777.28 669.03 908.76   1212    WY:KSQFT
 SUM           2 1965  2   4097    4946   2784   3822   4734   6383    WY:KSQFT
#EOR
```

Fig. 7.6. Sample habitat time series (ZMTS) file from HABNET. Years 1966-83 deleted for brevity.

time series file comes from the input file (ZHABIN). The units also come from the input file.

The very small numbers, 1.E–99 (meaning 1×10^{-99}), represent months in which the life stage has no biological habitat value. Zero is not used because zero can be confused with a realistic value.

HABNET Error Messages

Messages are divided into two categories: warning and fatal. In general, warning messages will not cause program termination; the job will do its best to continue. Fatal errors, however, will cause either immediate or delayed job termination, depending on the circumstances. The output file (ZOUT) will provide a summary of these messages.

HABNET Input File (ZHABIN) Warnings

*** WARNING 0 ***
FOUND [xxxx] INSTEAD OF PROPER UNITS. (Unrecognized units found on your HABNET input file.)

*** WARNING 2 *** TEMPERATURE FORMAT MUST BE 0, 1, OR 2. THE FORMAT ON THE INPUT FILE IS: [*n*].

*** WARNING 4 *** INVALID UNIT TYPE: [xxxxxxxxx]
FOUND ON YOUR HABNET INPUT FILE, LINE 3. (The third line of the HABNET input file must be either METRIC UNITS or ENGLISH UNITS.)

*** WARNING 6 ***
THE FIRST YEAR REQUESTED [year] IS OUT OF THE BOUNDS OF FLOW DATA [year].
I WILL START WITH THE FIRST YEAR ON THE FLOW DATA FILE.

*** WARNING 8 ***
THE FIRST YEAR REQUESTED [year] IS OUT OF BOUNDS OF CORRESPONDING FLOW AND TEMPERATURE DATA.
I WILL START WITH THE FIRST YEAR OF CORRESPONDING DATA [year].

*** WARNING 10 ***
THE LAST YEAR REQUESTED [year] IS GREATER THAN THE LAST YEAR OF FLOW DATA [year].
I WILL END WITH THE LAST YEAR OF FLOW DATA FILE.

*** WARNING 12 ***
THE LAST YEAR REQUESTED [year] IS OUT OF BOUNDS OF CORRESPONDING FLOW AND TEMPERATURE DATA.
I WILL END WITH THE LAST YEAR OF CORRESPONDING DATA [year].

*** WARNING 14 ***
YOUR REQUESTED MONTHS WERE BLANK.
YOU SHOULD SPECIFY THEM.
I WILL PROCEED WITH THEM ALL TURNED ON.
[the month indicators on the HABNET input file are blank.]

*** WARNING 16 ***
THE SEGMENT LENGTH FOR SEGMENT:
SEGMENT NUMBER: [number] IS ZERO.
[the segment length needs to be specified after the segment ID in the HABNET input file.]

*** WARNING 18 ***
THE MAXIMUM NUMBER OF [number] SEGMENTS HAS BEEN EXCEEDED.
THE FOLLOWING SEGMENT: [segment ID] WILL NOT BE INCLUDED IN PROCESSING.
[There are too many segments (current limit is 50) included in processing for the program to handle.]

*** WARNING 20 ***
THE FOLLOWING SEGMENT: [segment ID] IS INVALID OR NOT FOUND—IT WILL BE EXCLUDED FROM PROCESSING.

*** WARNING 22 ***
THE MAXIMUM NUMBER OF [number] LIFE STAGES HAS BEEN EXCEEDED.
THE FOLLOWING LIFE STAGE: [life stage] WILL NOT BE INCLUDED IN PROCESSING.
[There are too many life stages (current limit is 10) included in processing for the program to handle.]

*** WARNING 24 ***
THE FOLLOWING LIFE STAGE: [life stage] IS INVALID OR NOT FOUND—IT WILL BE EXCLUDED FROM PROCESSING.

*** WARNING 26 ***
NO VALID LIFE STAGES WERE FOUND IN [filename]. PROCESSING WILL CONTINUE WITHOUT LIFE STAGES.

Modified Habitat-Versus-Flow File (ZHAQFM) Warnings

*** WARNING 28 ***
AN END-OF-RECORD INDICATOR—********** WAS FOUND IN THE Q-HA FILE WITHOUT ANY DATA BEFORE IT. YOU MAY WISH TO CHECK THE DATA ON YOUR Q-HA FILE.
[You may have a record on your ZHAQFM file with no points.]

*** WARNING 30 ***
SEGMENT: [segment ID] WAS FOUND IN YOUR HABITAT-VERSUS-FLOW FILE, BUT NOT IN THE FLOW DATA FILE. PROCESSING WILL SKIP THIS SEGMENT.

*** WARNING 32 ***
BAD SPECIES LIFE STAGE [species/life stage] FOUND IN FILE. I WILL TRY TO RECOVER.

*** WARNING 34 ***
EXPECTED A NEW LIFE STAGE BUT FOUND AN END OF FILE.
I WILL TRY TO CONTINUE.
[The last record of the ZHAQFM file should end with **********.]

*** WARNING 36 ***
TOO MANY UNIQUE LIFE STAGES ENCOUNTERED.
I CAN ONLY HANDLE [number].
I WILL CONTINUE WITH WHAT I HAVE.
[There are too many life stages (current limit is 10) on the ZHAQFM file for the program to handle.]

*** WARNING 38 ***
TOO MANY POINTS IN CURVE. I ONLY HAVE ROOM FOR [number].
I WILL TRY TO RECOVER.
[There are too many discharges (current limit is 30) in your ZHAQFM file for the program to handle.]

*** WARNING 40 ***
FLOW DATA NOT INCREASING.
CHECK DATA FILE FOR [real number] IN [species/life stage].
[The discharges on the ZHAQFM file must be in ascending order for HABNET to work properly.]

*** WARNING 42 ***
THE SEGMENT: [segment ID] HAS NO FLOW–WUA DATA POINTS.
I WILL TRY TO CONTINUE.

Monthly Flow File (ZMTSM) Warnings

*** WARNING 44 ***
MONTHLY FLOW DATA FILE CONTAINS [number] SEGMENTS.
I ONLY HAVE ROOM FOR [number]. I WILL CONTINUE WITH THE MAXIMUM ALLOWED.
[There are too many segments (current limit is 50) on the ZMTSM file for the program to handle.]

*** WARNING 46 ***—THE SEGMENT:
[segment title]
SEGMENT: [segment ID]
IS A DITTO SEGMENT AND IS INDICATED TO BE COPIED FROM SEGMENT ID: [segment ID] WHICH HAS NOT BEEN DEFINED.
PROCESSING WILL IGNORE THIS SEGMENT.
[A ditto segment must copy data from a previous segment. A ditto segment on the monthly flow file does not match any of the previous segments.]

Monthly Temperature File (ZTEMP) Warnings

*** WARNING 48 ***
TEMPERATURE DATA CONTAINS [number] SEGMENTS.
I ONLY HAVE ROOM FOR [number]. I WILL CONTINUE WITH THE MAXIMUM ALLOWED.
[There are too many segments (current limit is 50) on the ZTEMP file for the program to handle.]

*** WARNING 50 ***—THE SEGMENT:
[segment title]
segment ID: [segment ID]
IS A DITTO SEGMENT AND IS INDICATED TO BE COPIED FROM
SEGMENT ID: [segment ID] WHICH HAS NOT BEEN DEFINED.
PROCESSING WILL IGNORE THIS SEGMENT.
[A ditto segment must copy data from a previous segment. A ditto segment on the monthly temperature file does not match any of the previous segments.]

*** WARNING 52 ***
THE SEGMENT: [segment ID] WAS ENCOUNTERED IN YOUR TEMPERATURE DATA FILE, BUT NOT FOUND IN YOUR MONTHLY FLOW DATA FILE.
PROCESSING SKIPS THIS SEGMENT COMPLETELY.

*** WARNING 54 ***
UNEXPECTED END FOUND ON TEMPERATURE DATA FILE: [filename] OR OPTIONAL TEMPERATURE DATA NOT PROVIDED.
ALL HABITAT WILL BE UNCONDITIONED BY TEMPERATURE.
[This warning will appear if you are not using temperature data, or if there is incorrect data or format on the ZTEMP file.]

Temperature Suitability File (ZTSI) Warnings

*** WARNING 56 ***
BAD SPECIES LIFE STAGE [species/life stage] FOUND IN FILE. I WILL TRY TO RECOVER.

*** WARNING 58 ***
LIFE STAGE [life stage] FOUND IN TEMPERATURE SUITABILITY FILE BUT IT WAS NOT FOUND IN YOUR Q–WUA FILE: [filename].
I WILL SKIP THIS RECORD.

*** WARNING 60 ***
EXPECTED MIN, AVG, OR MAX, BUT FOUND [xxx] INSTEAD.
REFERENCE SET TO AVG.

*** WARNING 62 ***
TOO MANY POINTS IN CURVE. I ONLY HAVE ROOM FOR [number].
I WILL TRY TO RECOVER.
[There are too many points (current limit is 15) in the temperature suitability curve for the program to handle.]

*** WARNING 64 ***
TEMPERATURE DATA NOT INCREASING. CHECK DATA FILE FOR [real number] IN [segment].
[The temperature data in the temperature suitability file must be in ascending order for HABNET to work properly.]

*** WARNING 66 ***
SI VALUE NOT BETWEEN ZERO AND ONE. CHECK DATA FILE FOR [real number] COORDINATES SKIPPED. I WILL TRY TO CONTINUE.
[HABNET uses a suitability index between 0 and 1.]

*** WARNING 68 ***
THIS LIFE STAGE HAS NO DATA POINTS. I WILL TRY TO CONTINUE.

*** WARNING 70 ***
UNEXPECTED END FOUND ON TEMPERATURE SUITABILITY FILE: [filename] OR OPTIONAL TEMPERATURE SUITABILITY DATA NOT PROVIDED.
ALL HABITAT WILL BE UNCONDITIONED BY TEMPERATURE.
[This warning will appear if you are not using temperature data or if there is incorrect data or format on the ZTSI file.]

*** WARNING 72 ***
NOT ABLE TO READ LIFE STAGES FROM TEMPERATURE SUITABILITY FILE. CHECK TO SEE IF THE TEMPERATURE FORMAT ON THE INPUT FILE IS CORRECT.
[Either there is an error in the ZTSI file or the wrong temperature format was specified (expecting a network temperature suitability index file).]

*** WARNING 74 ***
NOT ABLE TO READ LIFE STAGES FROM TEMPERATURE SUITABILITY FILE. CHECK TO SEE IF THE TEMPERATURE FORMAT ON THE INPUT FILE IS CORRECT.
[Either there is an error in the ZTSI file or the wrong temperature format was specified (expecting a FISHCRV file).]

*** WARNING 76 ***
ILLEGAL DATA ON TEMPERATURE SUITABILITY FILE.

*** WARNING 78 ***
THE SPECIES/LIFE STAGE: [species/life stage] HAS NO HABITAT SUITABILITY CURVE. THE DATA FOR THIS LIFE STAGE WILL NOT BE TEMPERATURE CONDITIONED.
[This life stage was not included on your ZTSI file.]

*** WARNING 80 ***
FOR: [species/life stage] AT [segment ID] YEAR: [xxxx] MONTH # [x] TEMPERATURE OF [real number] IS BELOW LOWEST POINT IN T-SI CURVE.
NO SUITABILITY INDEX WILL BE CALCULATED.
YOUR TIME SERIES DATA MAY BE ERRONEOUS.
[The month (#) displayed is the *order* of the month in the ZTEMP file. For example, if the first month of data in the file is for October, month #11 would be August. If the first month of data is for January, then month #11 would be November.]

*** WARNING 82 ***
FOR: [species/life stage] AT [segment ID] YEAR: [xxxx] MONTH # [x] TEMPERATURE OF [real number] IS ABOVE HIGHEST POINT IN T-SI CURVE.
*** NO SUITABILITY INDEX WILL BE CALCULATED.***
*** YOUR TIME SERIES DATA MAY BE ERRONEOUS.***
[The month (#) displayed is the *order* of the month in the ZTEMP file. For example, if the first month of data in the file is for October, month #11 would be August. If the first month of data is for January, then month #11 would be November.]

Warnings for problems found in producing the monthly time series file (ZMTS)

*** WARNING 84 ***
THE LIFE STAGE: [life stage] WILL NOT BE PROCESSED.
THE TIME SERIES DATA THAT WOULD BE PRODUCED WOULD BE PARTIALLY TEMPERATURE CONDITIONED. THIS DATA WOULD BE ERRONEOUS.

*** WARNING 86 ***
NO TEMPERATURE DATA OR TEMPERATURE DATA INCOMPLETE.
SEGMENT NUMBER: [number] ID: [segment ID]
TEMPERATURE CONDITIONED HABITAT WILL NOT BE PRODUCED FOR THIS SEGMENT.

*** WARNING 88 ***
FOR [species/life stage] AT [segment ID] FLOW OF [real number] IS BELOW LOWEST FLOW IN Q–HA RELATIONSHIP
[This flow is below the lowest flow on the ZHAQFM file.]

*** WARNING 90 ***
FOR [species/life stage] AT [segment ID] FLOW OF [real number] IS GREATER THAN HIGHEST FLOW IN Q–HA CURVE.
[This flow exceeds the highest flow on the ZHAQFM file.]

*** WARNING 92 ***
YEAR = [year] MONTH = [month] FLOW OF [real number]
PROVIDED AN AREA OF [real number]. THIS IS BELOW YOUR THRESHOLD OF [real number].
[The habitat area computed for this flow, time, and segment was below the limit given on the ZHAQFM file.]

Fatal Errors

$$$ FATAL ERROR 2 $$$
THERE WAS NO DATA FOR REQUESTED YEARS [. . .] OR [. . . '].
THERE WERE NO CORRESPONDING YEARS OF FLOW AND TEMPERATURE DATA.
PROCESSING CAN NOT CONTINUE.
[The data files do not contain a full set of needed data for any segment, any year. Check your files to make sure the segment ID's are labeled correctly.]

$$$ FATAL ERROR 4 $$$
NO VALID SEGMENTS WERE FOUND IN HABNET INPUT FILE: [filename]. PROCESSING CANNOT CONTINUE.
[Either the processing indicator characters before each segment were not '1' ('T' or 't' also works) or the segment ID's do not match the rest of the data.]

$$$ FATAL ERROR 6 $$$
UNEXPECTED END FOUND ON HABNET INPUT FILE: [filename].
PROCESSING CANNOT CONTINUE.

$$$ FATAL ERROR 8 $$$
DID NOT GET SUFFICIENT DATA FROM LIFE STAGE FILE TO CONTINUE WITH PROCESSING.
[You have no valid life stages or data on the ZHAQFM file.]

$$$ FATAL ERROR 10 $$$
UNEXPECTED END FOUND ON MONTHLY FLOW FILE: [filename].

$$$ FATAL ERROR 12 $$$
WRONG DATA FOUND IN MONTHLY FLOW FILE: [filename].

$$$ FATAL ERROR 14 $$$
UNEXPECTED PROBLEM WITH INTERNAL SCRATCH FILE (IOSCR). THE MONTHLY FLOW DATA IS READ INTO THIS INDEXED FILE.
[You should not get this error. Either there is an undetected error in your monthly flow data or there is an error in the program.]

$$$ FATAL ERROR 16 $$$
UNEXPECTED PROBLEM WITH INTERNAL TEMPERATURE SCRATCH FILE. THE TEMPERATURE DATA IS WRITTEN TO THIS FILE.
[You should not get this error. Either there is an undetected error in your monthly flow data or temperature data, or there is an error in the program.]

$$$ FATAL ERROR 18 $$$
UNEXPECTED PROBLEM WITH INTERNAL FLOW SCRATCH FILE.
THE FLOW DATA IS READ FROM THIS FILE.
[You should not get this error. Either there is an undetected error in your monthly flow data or there is an error in the program.]

$$$ FATAL ERROR 20 $$$
PROBLEM WITH SCRATCH FILE IN SUBROUTINE WRITHTS.
[You should not get this error. Either there is an undetected error in your monthly flow data or temperature data, or there is an error in the program.]

HABTS Program

Introduction

The HABTS program creates a monthly physical habitat time series file for multiple species and life stages using the following equation:

$$HA_t = PH(Q_t),$$

where

Q_t is the average or median flow for month t,

PH( ) is the physical habitat-versus-streamflow function, and

HA_t is the physical habitat for month t.

The program calculates monthly habitat values at the site, using linear or nonlinear interpolation for each species and life stage.

Two sets of relations are used as input to HABTS. The first is the habitat area-versus-streamflow flow relation for the species and life stages of interest (ZHAQF file). Up to four species, each with up to five life stages, can be considered in each program run. This habitat area-versus-streamflow file (ZHAQF) is generated by the habitat simulation programs in the physical habitat simulation system (PHABSIM) or can be created using the CRHAQF program. A maximum of 30 habitat area-versus-flow pairs is acceptable. The flows *must* be in ascending order.

The second set of relations used as input to HABTS is flow versus time, in months, at the site of interest (ZMONQ file). This file can be in either USGS or NWDC format. The maximum permissible number of flow-versus-time data pairs is 1,200 (100 years of data). The ZMONQ file can be created by the QIN program, or the DQTOMQ program could be run to convert a daily streamflow file to a monthly streamflow file in NWDC format.

Running HABTS

RHABTS, ZHAQF, ZMONQ, ZMTS, ZOUT

ZHAQF = Habitat area-versus-streamflow file (input).

ZMONQ = Monthly streamflow file in USGS or NWDC format (input).

ZMTS = Monthly habitat time series file with multiple records in the same format as the ZMONQ input file (output).

ZOUT = HABTS results (output).

```
ENTER RECORD NAME (5 CHAR)
```

On the ZMTS output file, the data for each species/life stage is written as a separate section, terminated by #EOR, and is preceded by a header-line containing a user-designated label and a sequential numbering system.

For example, if CLASS is entered here as the record name, the very top line on the ZMTS file will contain CLASSA1. Following this line will be two title lines, then the USGS formatted habitat data for the first species, first life stage. Next there will be a line containing CLASSA2, followed by two title lines and the data for the first species, second life stage. Following all life stages of the first species, the line will contain CLASSB1 for the second species, first life stage, and so on. In other words, each species will begin a new letter (A–D) and each life stage will begin a new number (1–5).

```
ENTER 1 FOR LINEAR INTERPOLATION, 2 FOR NONLINEAR.
```

If 2 is entered for NONLINEAR, the following prompt will appear.

```
ENTER 1 FOR LINEAR TAILS, 2 FOR NONLINEAR.
```

Flow values in the flow-versus-time series that are smaller than lowest flows or greater than highest flows in the flow-versus-habitat relation are considered tail flows. Habitat values for these tail flows must be extrapolated, as described in the "HABTS Calculations" section. Indicate whether the extrapolation should be linear or nonlinear. Do not use nonlinear extrapolation for any serious analysis unless you know what you are doing. This program could give negative or wildly irrational results for nonlinear extrapolation, and you should know how to handle this problem.

```
ENTER SCALING FACTOR FOR ALL HABITAT TIME SERIES OUTPUT VALUES,
OR 1 TO LEAVE VALUES IN ORIGINAL UNITS.
```

This is useful for creating total habitat values (ft^2) from areas that were originally in ft^2/1,000 ft of stream. For example, if your segments were 10 miles long, you could multiply the habitat values by 10 * 5.28 (or 52.8) to produce total habitat in square feet.

```
THIS MAY TAKE A WHILE . . .
```

The cursor will be at the end of this message. This is an indication that the program is making calculations. These calculations may take several minutes to compute. Do not reset the machine; wait until the DOS prompt returns.

The output file generated by HABTS is similar to the output file generated by HABTD (Chapter 6).

HABTS Calculations

Each species/life stage is processed separately.

Habitat Factors. The first calculations performed by program HABTS involve habitat area-versus-flow data only. For linear interpolation, let n = the number of habitat area-versus-flow pairs provided as input for a given species/life stage. Then,

$$B_i = \frac{H_i + 1 - H_i}{Q_i + 1 - Q_i}$$

where

i = 1, 2, 3, . . . n,

H_i = habitat area for pair i,

Q_i = flow for pair i, and

B_i = habitat factor (slope) B for pair i.

There will be a total of $n - 1$ habitat factor B's calculated.

Then,

$$A_i = H_i - (B_i * Q_i),$$

where

i = 1, 2, 3, . . . n,

H_i = habitat area pair i,

Q_i = flow for pair i,

B_i = habitat factor B for pair i, and

A_i = habitat factor (intercept) A for pair i.

There will be a total of $n - 1$ habitat factor A's calculated.

These habitat factors [A(1 through $n - 1$) and B(1 through $n - 1$)] will be used later in calculating the monthly habitat area at the specific site. For nonlinear interpolation, habitat factors A_i, B_i, C_i, and D_i are Lagrangian parameters (see Milne 1949). The flows, habitat areas, and habitat factors are all written to ZOUT in a tabular format.

Comparison of Flows. The HABTS program then compares all the flows provided in the flow-versus-time pairs with the flow-versus-habitat area pairs. It will flag any flows of the former set that are greater than the highest flow or less than the lowest flow of the latter set. Warnings of these flagged data are written to ZOUT. The program will proceed even if such values are found.

Available Monthly Physical Habitat. Using the flows provided on the flow versus time input file, and the habitat factors calculated (see *Habitat Factors*), a habitat value for each month of each year for which flow versus time was provided is calculated. The following equation is used for linear interpolation:

$$H = A_i + (B_i * Q)$$

where

H = the physical habitat available at the site for the given month and year,

A_i = habitat factor (calculated in *Habitat Factors* section) that corresponds to habitat factor B_i in this equation,

B_i = habitat factor (calculated in *Habitat Factors* section) that applies to the flow interval in which Q resides and the given species and life stage, and

Q = the flow for the given month and year at the site of interest.

For nonlinear interpolation, the following formula is used:

$$H = (A_i * Q^3) + (B_i * Q^2) + (C_i * Q) + D_i,$$

where

H = the physical habitat available at the site for the given month and year,

A_i, B_i, C_i, D_i = Lagrangian parameters, as discussed in *Habitat Factors* section, and

Q = the flow for the given month and year at the site of interest.

This calculation is repeated for each flow-versus-time data set.

When linear interpolation of tails is selected, the flow values flagged in the *Comparison of Flows* section are processed by extrapolating from the two highest or two lowest flow values provided in the flow-versus-habitat relation.

Nonlinear interpolation of tails is performed using the following equation:

$$H = (B_i * Q^2) + (C_i * Q) + D_i,$$

where

H = the physical habitat available at the site for the given month and year,

B_i, C_i, D_i = Lagrangian parameters, as discussed in the *Habitat Factors* section, and

Q = the flow for the given month and year at the site of interest.

Negative values are not set equal to 0. The user should be aware of this process, and interpret the results accordingly.

HQFMON Program

Introduction

The HQFMON program adds month indicators and minimum habitat values to a habitat area-versus-streamflow (ZHAQF) file. An extra title line and segment ID line can also be added if they were not previously entered with an editor. The resulting file is used as input to the HABNET program.

Month indicators inform the HABNET program what months to process for each species and life stage. The minimum habitat value is a habitat threshold. Any value below the value entered will produce a warning message if the population's usable area falls below it in any month.

Figure 7.7 contains a partial modified monthly flow time series file in USGS format (ZHAQFM) created by the HQFMON program. A complete ZHAQFM file is included in your sample data sets. Appendix A contains the file format for a ZHAQFM file.

Running HQFMON

RHQFMON, ZHAQF, ZHAQFM

ZHAQF = Habitat area-versus-streamflow file (input).

ZHAQFM = Habitat area-versus-streamflow file with month indicators and minimum habitat values (output). An extra title line and segment ID line can also be added if they were not previously entered with an editor. This file is used as input to the HABNET program.

```
ENTER   0 TO ADD A TITLE LINE TO EACH LIFE STAGE
        1 TO ADD A TITLE LINE TO RECORD ONLY
        2 TO NOT ADD OR CHANGE TITLE LINES
```

Extra title lines may be entered. These extra title lines would be the third line in the file and the first line in each species/life stage record—records are separated by at least 10 asterisks (**********). These title lines are not required by the HABNET program, but they do help label the information. Other PHABSIM applications may require that these title lines be deleted.

Entering 0 allows you to enter separate title lines for *every* life stage in the file. The input ZHAQF file may either have records grouped by life stage or may be grouped by species with multiple life stages in each record. Remember, records are separated by at least 10 asterisks (**********).

Entering 1 allows you to have the same title line entered for *all* life stages for a species when the records in the input file were grouped by species with multiple life stages.

```
ENTER   0 TO ADD A SEGMENT ID TO EACH LIFE STAGE
        1 TO ADD A SEGMENT ID TO EACH RECORD ONLY
        2 IF THE FILE ALREADY HAS SEGMENT ID'S
```

A segment ID line is required by the HABNET program. It follows the extra title line in each record or is the first line in each record if extra title lines were not added. The segment ID numbers have to match exactly with the segments ID numbers read from the gaging station data file (ZMTSM), the HABNET input file (ZHABIN), and the temperature time series or temperature-versus-flow relation file (ZTEMP). Once again, other PHABSIM applications may require that these lines be deleted.

Entering 0 allows you to enter separate segment ID numbers for *every* life stage in the file. Remember, the input ZHAQF file may either have records grouped by life stage or grouped by species with multiple life stages in each record. Remember, records are separated by at least 10 asterisks (**********).

Entering 1 allows you to have the same segment ID number entered for *all* life stages for a species when the records in the input file were grouped by species with multiple life stages.

```
HABNET ALLOWS YOU TO INDICATE THE APPLICABLE MONTHS
TO PROCESS FOR EACH SPECIES AND LIFE STAGE ON THE ZHAQF FILE.
A '1' INDICATES THAT THE MONTH IS TO BE PROCESSED,
A '0' INDICATES THAT THE MONTH IS NOT TO BE PROCESSED.

ENTER   0 IF YOU WISH TO ADD MONTH INDICATORS FOR
          EACH LIFE STAGE
        1 IF YOU WISH TO ADD MONTH INDICATORS FOR
          EACH RECORD ON THE ORIGINAL FILE
        2 IF YOU WISH TO ADD THE SAME MONTH INDICATORS
          FOR EVERY LIFE STAGE IN THE DATA SET.
```

The processing of each month is determined from *both* the HABNET input file (ZHABIN) and the habitat-versus-flow file with month indicators (ZHAQFM). Both month indicators must be "on" to be processed. Some examples follow:

If month indicator is 1 in ZHABIN and 1 in ZHAQFM, then that month *will* be processed for that species, life stage, and location.

If month indicator is 1 in ZHABIN and 0 in ZHAQFM, that month *will not* be processed for that species, life stage, and location.

If month indicator is 0 in ZHABIN and 1 in ZHAQFM, that month *will not* be processed for that species, life stage, and location.

If month indicator is 0 in ZHABIN and 0 in ZHAQFM, that month *will not* be processed for that species, life stage, and location.

Entering 0 allows you to enter separate month indicators for *every* life stage in the file.

Entering 1 allows you to have the same month indicators entered for *all* life stages for a species when the records in the input file were grouped by species with multiple life stages.

Entering 2 enters the same month indicators for *every* life stage of *every* species in the original data set.

If 2 is entered:

```
ENTER 1 OR 0 FOR EACH APPLICABLE MONTH FOR ALL RECORDS
AND LIFE STAGES.
(EX., 110000000011)
```

Note: The months should be in the same format for all input files (ZHABIN, ZMTSM, ZHAQFM, and ZTEMP)—that is, all in water years, calendar years, and so forth.

```
HABNET ALSO ALLOWS YOU TO ADD A MINIMUM HABITAT FACTOR
TO EACH LIFE STAGE ON THE ZHAQFM FILE. HABNET COMPARES
THE AREA THAT IT CALCULATES WITH THE VALUE GIVEN AND
GIVES A WARNING MESSAGE IF THE CALCULATED HABITAT IS
TOO LOW.

ENTER   0 IF YOU WISH TO ADD MINIMUM HABITAT VALUES
          FOR EACH LIFE STAGE
        1 IF YOU WISH TO ADD MINIMUM HABITAT VALUES
          FOR EACH RECORD ON THE ORIGINAL FILE
        2 IF YOU WISH TO ADD THE SAME MINIMUM HABITAT
          VALUE FOR EVERY LIFE STAGE IN THE DATA SET.
```

The minimum habitat value is a habitat threshold. Any value below the value entered will produce a warning message if the population's usable area falls below it in any month.

Entering 0 allows you to enter separate minimum habitat values for *every* life stage in the file.

Entering 1 allows you to have the same minimum habitat values entered for *all* life stages for a species when

```
CACHE LA POUDRE RIVER FLOW VS. HABITAT (WUA SQ. FT PER FT.) FUNCTIONS
SECOND MAIN TITLE LINE
POUDRE RIVER SEGMENT 1 SITE 5 (Extra title line)
SEG 1.5 (Segment ID line)
BROWN                          111111111111    0.0
      DISCHARGE  ADULT     (Month Indicators) (Habitat Threshold)
          0.00         0.
         25.00     13000.
         50.00     16500.
        100.00     19400.
        200.00     19000.
        300.00     15000.
        500.00     10000.
        700.00      7900.
        900.00      6400.
       1000.00      5800.
       2000.00      4100.
       3000.00      4000.
       5000.00      4000.   Arbitrarily extended
**********
POUDRE RIVER SEGMENT 1 SITE 5
SEG 1.5
BROWN                          111111111111    0.0
      DISCHARGE  JUVENILE
          0.00         0.
         25.00     15000.
         50.00     21000.
        100.00     28000.
        200.00     25700.
        300.00     20200.
        500.00     14200.
        700.00     10200.
        900.00      7400.
       1000.00      7000.
       2000.00      4100.
       3000.00      3500.
       5000.00      3500.   Arbitrarily extended
**********
```

Fig. 7.7. Sample ZHAQFM file used as input to HABNET.

the records in the input file were grouped by species with multiple life stages.

Entering 2 enters the same minimum habitat value for *every* life stage of *every* species in the original data set.

If 2 is entered:

```
ENTER THE MINIMUM HABITAT (RED FLAG) VALUE FOR ALL
RECORDS AND LIFE STAGES:
```

The following prompts will appear for each species and life stage record in the input file (ZHAQF), depending on what options were chosen:

```
ENTER A NEW TITLE LINE FOR THIS LIFESTAGE (or RECORD) (80 CHARS MAX):

ENTER A SEGMENT ID (8 CHARS MAX) FOR THIS LIFESTAGE (or RECORD):
```

Remember, the segment ID numbers have to match exactly with the segments ID numbers read from the gaging station data file (ZMTSM), the HABNET input file (ZHABIN), and the temperature time series or temperature-versus-flow relation file (ZTEMP).

```
ENTER 1 OR 0 FOR EACH APPLICABLE MONTH FOR THIS LIFE STAGE
(or RECORD):
```

Remember, the processing of each month is determined from *both* the HABNET input file (ZHABIN) and the habitat-versus-flow file with month indicators (ZHAQFM). Both month indicators must be "on" to be processed. The months should be in the same format for all input files (ZHABIN, ZMTSM, ZHAQFM, and ZTEMP)—that is, all in water years, calendar years, and so forth.

```
ENTER THE MINIMUM HABITAT (RED FLAG) VALUE FOR THIS
LIFE STAGE(or RECORD):
```

QTEM Program

Introduction

The QTEM program generates a temperature-versus-flow equation (ZTEMP) file for use with the HABNET program. This file is a free-formatted file where the user supplies parameters so that temperature is calculated as a function of flow for each of the 12 time steps per year at each geographic location. The formulation is

$$T_i = a_i + b_i \log Q_i + c_i Q^{d_i}$$

where

T_i = calculated temperature for time step i,

a_i, b_i, c_i, d_i = empirically derived coefficients for time step i, and

$\log Q_i$ = natural log (base e) or discharge Q for time step i.

The B-coefficient term will only be valid down to flows of 1 cfs or 1 cms. If flows are below 1, the whole term will drop out of the temperature calculation equation. In other words, we really have a set of equations that looks like this:

If $Q \geq 1$,

$$T = a + b \ln(Q) + c\, Q^d.$$

If $Q < 1$,

$$T = a + c\, Q^d.$$

Type INFOTQ for on-line information on the format of this file. Figure 7.8 contains a sample free-formatted ZTEMP file created by the QTEM program.

The ZTEMP file also can contain temperature data in USGS or NWDC format. This file is in the same format as the ZMTSM file except that it contains temperature data instead of flow data. Refer to Appendix A for the format of the ZTEMP file.

Running QTEM

RQTEM, ZTEMP

ZTEMP = free-formatted flow-versus-temperature equation file (output).

```
ENTER 3 TITLE LINES (80 CHARS MAX EACH):
```

These title lines are for identification of the data.

```
ENTER A SEGMENT ID NUMBER:
```

The segment ID numbers have to match exactly with the segments ID numbers read from the gaging station data file (ZMTSM), the HABNET input file (ZHABIN), and the habitat area-versus-streamflow file (ZHAQFM).

```
THE HABNET PROGRAM USES THE FOLLOWING EQUATIONS:

If q ≥ 1,
Temperature = A + B * ln(q) + C * q ** D.

If q < 1,
Temperature = A + C * q ** D
 where q = discharge.

ENTER A, B, C, AND D FOR SEGMENT (segment ID number):
BY MONTH:
```

> Note: The months should be in the same format for all input files (ZHABIN, ZMTS, ZHAQFM, and ZTEMP)—that is, all in water years, calendar years, and so forth.

Data may be entered using commas or spaces as separators or entered one or more per line.

```
ENTER   1 TO ADD ANOTHER SEGMENT
        0 TO EXIT.
```

```
Temperature (F) versus flow (cfs) file for Poudre River Network
Water year organization
Data from SSTEMP approximations (Temperature predictions in Degrees F)
TQ
SEG 1.5
   1     40.660     1.470     0.000     0.000
   2     22.920     3.700     0.000     0.000
   3     22.300     3.510     0.000     0.000
   4     22.160     3.470     0.000     0.000
   5     22.690     3.630     0.000     0.000
   6     27.860     3.080     0.000     0.000
   7     37.620     1.850     0.000     0.000
   8     58.000    -0.610     0.000     0.000
   9     70.230    -2.000     0.000     0.000
  10     74.600    -2.490     0.000     0.000
  11     69.320    -1.900     0.000     0.000
  12     55.080    -0.270     0.000     0.000
**********
```

Fig. 7.8. Sample ZTEMP file created by the QTEM program.

Chapter 8. Manipulation, Analysis, and Display of Monthly Time Series Data

Introduction

The monthly streamflow and physical habitat values in themselves tell us little unless we analyze and display the results. The programs presented in Chapter 8 are used to manipulate, analyze, and display the monthly time series data (Fig. 8.1). In many situations, this should be considered an intermediate step before proceeding to the generation of an annual time series.

In the absence of good, long-term biological data on population sizes, biomass, survivorship, fecundity, and emigration–immigration, we must use some measure of habitat as an index to measure alternative operations plans. In other words, we need some measure of system performance to know whether we are getting better or worse than the existing condition.

Several alternative indices have been proposed for this task, each of which has a different utility and none of which appears to have universal applicability. Each must be qualified as to appropriate time of year, time step, spatial extent, and unit measure (e.g., HA, WUA, degree days). In this discussion, we will confine ourselves to consider indices of the time series of habitat values. The alternative indices are each meant to characterize the *effective* habitat and are as follows:

a. Average,
b. Median,
c. Index-A,
d. Index-B,
e. Index-C,
f. Minimum,
g. Maximum,
h. Some fixed exceedence statistic, and
i. Some combination.

The average value is the intuitively obvious choice. It provides a good integration of all events but may mask the extremes that really control a population. For example, increasing the value of habitat highs and decreasing habitat lows may result in the same average value. If it were the lows that were thought to be controlling, the average is not a good measure of performance. Similarly, for a hydropeaking situation, habitat values may swing dramatically from high to low—the average may never really occur and thus may be a misleading statistic.

The median may often be a better measure of central tendency than the average, with 50% of the events being of greater value and 50% of lesser value. The median is not as sensitive to high or low extremes; however, like the average, the median may not be expressive of habitat bottlenecks and may never actually occur.

Index-A is the average of the habitat values between the 50% and 90% exceedence levels—that is, index-A reflects the majority of the lowest habitat events. If these events are thought to limit the population, index-A might be a good measure of habitat value. However, if a species is thought to take advantage of high habitat values through growth or reproductive success, this index may not be a good measure.

Index-B is similar to what is called a trimmed mean. It is the average of the values between the 10% and 90% exceedence levels. Similar to the average, index-B only omits the very highest and very lowest habitat events. Index-B may be a good replacement for the average, but probably has little utility beyond that.

Index-C is a user-defined exceedence category. This index may be useful if the exceedence values described by index-A and index-B are irrelevant to your application or do not cover the percentages of interest. For example, if the events in the 90–100% exceedence category are thought to be important population limiting events, then you may wish to define index-C as covering the 90–100% exceedence category.

Fixed exceedence levels can make a lot of sense in some cases. For example, the 90% exceedence level is a good representation of the lowest habitat events, but discounts those 10% that will occasionally occur. Similar to the minimum, the 90% value typifies habitat minima. A variation on this theme is the use of the recurrence interval for habitat peaks or troughs.

The minimum is another intuitive measure. If habitat bottlenecks are thought to be caused by habitat minima, this is the obvious choice. Often the minimum is used on an annual basis, followed by a duration analysis of this minimum series. Beware of situations where the annual minimum value does **not** change but its frequency increases.

The maximum is the opposite of the minimum. This index may be appropriate for something like spawning if the species is thought to take advantage of good spawning conditions during some period. For species that require a

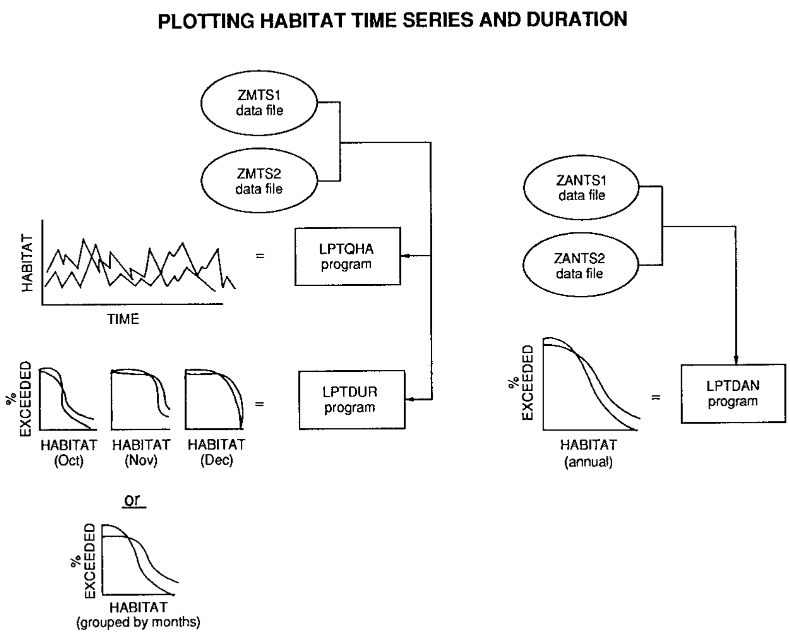


Fig. 8.1. Plotting habitat time series and duration.

good year class only every few years to be successful, the maximum value may be a good measure.

Combinations of indices may be appropriate in some cases. In fact, no matter what index is used, a supporting rationale must be present. It might be worthwhile to look at a brief example of comparison, not so much for what any given study results should look like, but just to reinforce the concepts. Figure 8.2 is a habitat time series baseline-versus-operation alternative 1; Fig. 8.3 displays the corresponding habitat duration curve; and Fig. 8.4 compares several of the habitat indices for the same data.

In an actual time series analysis, one would compare the habitat index for the baseline condition with the habitat indices for each alternative operational scenario; compute and record amounts of habitat gained or lost with each alternative; postulate causes (e.g., high flows, low flows, fluctuating flows, habitat loss to inundation) of unacceptable change in habitat index; and recommend alternatives and request analysis of your alternatives or conduct your own analysis.

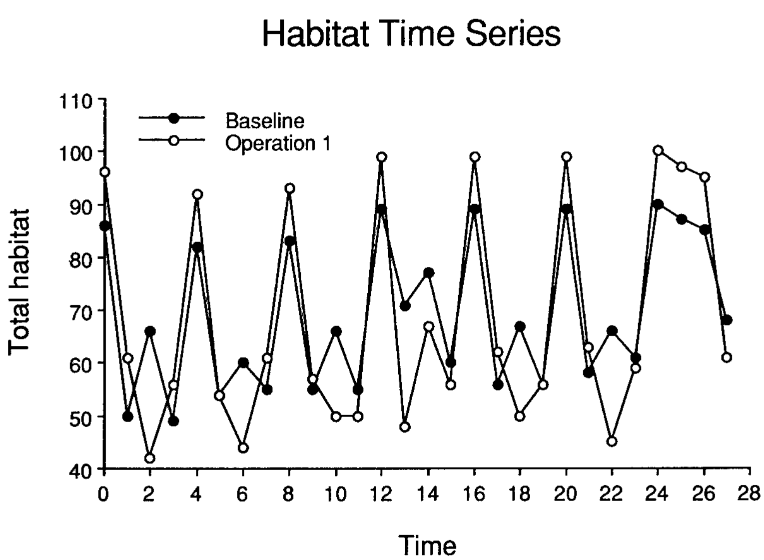


Fig. 8.2. Habitat time series—baseline-versus-operation alternative 1.

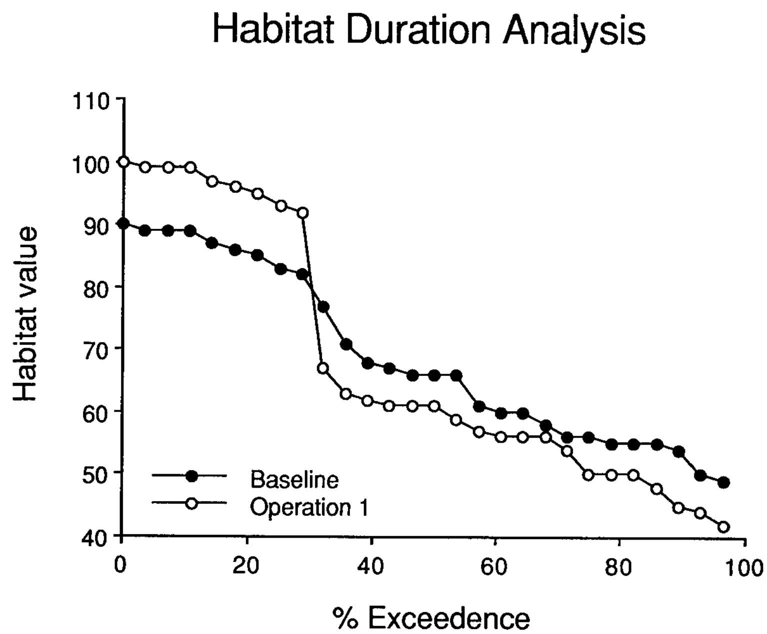


Fig. 8.3. Habitat duration curve—baseline-versus-operation alternative 1.

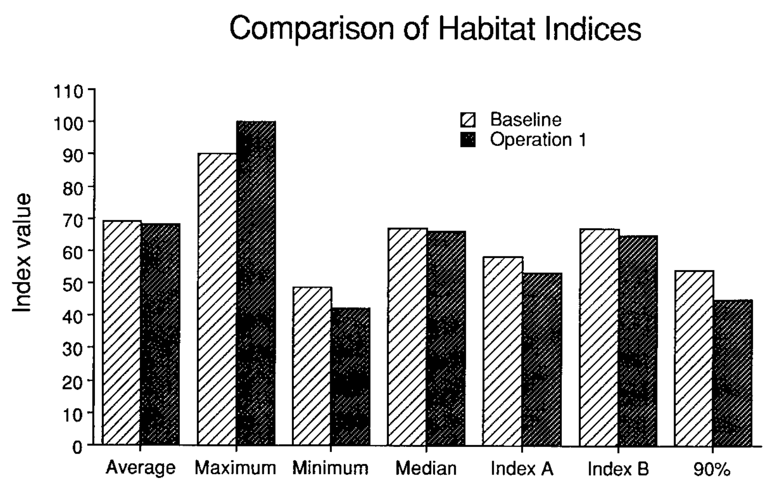


Fig. 8.4. Comparison of several of the habitat indices for the same data.

Manipulating Monthly Time Series Data

Program Name	Batch/Procedure Filename	Function	Program Description
CHGFMT	**RCHGFMT**	Monthly time series manipulation	Changes a USGS format file to a NWDC format file or vice versa. **RCHGFMT, ZMTS, ZMTSN** **ZMTS** = Monthly time series file in USGS or NWDC format; can be multirecord file (input). **ZMTSN** = New monthly time series file in NWDC or USGS format; will be multirecord if ZMTS is (output).
COMMTS	**RCOMMTS**	Monthly time series manipulation	Sums two USGS formatted files month by month with given weights. **RCOMMTS, ZMTS1, ZMTS2, ZMTSN** **ZMTS1** = Monthly time series file in USGS format; can be multirecord (input). **ZMTS2** = Monthly time series file in USGS format; can be multirecord (input). **ZMTSN** = Combined monthly time series file in USGS format (output).
MULMTS	**RMULMTS**	Monthly time series manipulation	Multiplies all the data in a monthly time series file in USGS or NWDC format by a constant. The output file is in the same format as the input file. **RMULMTS, ZMTS, ZMTSN** **ZMTS** = Monthly time series file; can be multirecord file (input). **ZMTSN** = New monthly time series file after multiplication (output).
SELMTS	**RSELMTS**	Monthly time series manipulation	Allows selection of individual months or groups of months from two or more monthly time series data files to create a single, composite monthly time series file. **RSELMTS, ZMTSN, ZMTS** **ZMTSN** = New monthly time series file in the same format as the input files (output). **ZMTS** = A base monthly time series file to be used as a building block; can be multirecord (input). User will be prompted to enter filenames for other ZMTS files to select months from. Note: All input files must be in the same format (USGS or NWDC), contain the same number of years, and begin with the same month.

Program Name	Batch/Procedure Filename	Function	Program Description
GET1	**RGET1**	Time series manipulation	Extracts records from a multirecord file. **RGET1, ZIN, ZOUT** **ZIN** = Multirecord file (input). **ZOUT** = File with selected records (output).

Displaying Monthly Time Series Data

Program Name	Batch/Procedure Filename	Function	Program Description
LPTQHA	**RLPTQHA**	Displaying monthly time series data	Plots monthly habitat area or streamflow from one or two monthly time series files, approximately five years per page. Program has the option to plot the Y-axis using either a logarithmic or linear scale. If the minimum data value is less than the maximum data value divided by 50.0, then the Y-axis will be logarithmic. **RLPTQHA, ZOUT, ZMTS, ZMTS2** **ZOUT** = LPTQHA results (output). **ZMTS** = Monthly time series file in USGS or NWDC format (input). **ZMTS2** = Second monthly time series file in USGS or NWDC format (input). Note: Input files do not have to be in the same format or contain the same number of years; however, they must begin with the same month. Multirecord files may be used.
LPTTSN	**RLPTTSN**	Displaying monthly time series data	Reads up to five monthly time series files in USGS or NWDC format and plots the data in a user-specified range of years. Output includes tables and plots. **RLPTTSN, ZOUT, ZMTS1, ZMTS2, ZMTS3, ZMTS4, ZMTS5** **ZOUT** = LPTTSN results (output). **ZMTS** = 1–5 monthly time series files in USGS or NWDC format (input). Note: Input files do not have to be in the same format or contain the same number of years; however, they must begin with the same month. Multirecord files cannot be used.

Program Name	Batch/Procedure Filename	Function	Program Description
MTSLST	**RMTSLST**	Displaying monthly time series data	Produces a formatted table of monthly time series values and their averages. These tables are useful for exporting to LOTUS 1-2-3 or other application programs. **RMTSLST, ZMTS, OUTMON, OUTAVG** **ZMTS** = Monthly time series file, can be multirecord (input). **OUTMON** = Table of time series data listed monthly for each year (output). **OUTAVG** = Table of average monthly and coefficient of variation values (output).

Analyzing Monthly Time Series Data

Program Name	Batch/Procedure Filename	Function	Program Description
SCORTS	**RSCORTS**	Analysis of monthly time series data	Reads a monthly time series file and calculates several statistical parameters, including log normal distribution, and lag one correlation coefficients. **RSCORTS, ZMTS, ZOUT, ZANTS** **ZMTS** = Monthly time series file in USGS or NWDC format; can be multirecord (input). **ZOUT** = SCORTS results (output). **ZANTS** = Average of 12 monthly values for each year (output).
LPTDUR	**RLPTDUR**	Analysis of monthly time series data	Reads one or two monthly time series files and creates an output file arranged either by groups of months or by individual months. The output contains annual duration tables showing ordered monthly data for each month or for each group of months, an exceedence plot for each month, a summary statistics table showing average, median, index-A, index-B, index-C, 10%, 20%, 80%, 90% exceedence, and plots showing median, average, change in median, and change in average for the two data sets. **RLPTDUR, ZOUT, ZMTS, ZMTS2** **ZOUT** = LPTDUR results (output). **ZMTS** = Monthly time series file in USGS or NWDC format (input). **ZMTS2** = Second monthly time series file in USGS or NWDC format (input). Note: Input files do not have to be in the same format or contain the same number of years; however, they must begin with the same month. Input files may be multirecord.

CHGFMT Program

Introduction

The CHGFMT program changes a USGS format file to a NWDC format file or vice versa. The files can be any type of monthly time series format that includes monthly streamflow files (ZMONQ).

Running CHGFMT

RCHGFMT, ZMTS, ZMTSN

ZMTS = Monthly time series file in USGS or NWDC format; can be a multirecord file (input).

ZMTSN = New monthly time series file in NWDC or USGS format; will be a multirecord file if ZMTS is (output).

COMMTS Program

Introduction

The COMMTS program reads two USGS formatted records and does a month by month weighted sum of the two. All common years of the two input files will be combined according to the responses given by the user at run time. If the data is out of order, the user will be notified.

The monthly time series files must be in USGS format; use the CHGFMT program to change from NWDC to USGS format, if needed.

The equation used in the COMMTS program is

$$HAC_{ij} = A * HA1_{ij} + B * HA2_{ij},$$

where

j = the month index,

i = the year index,

HAC_{ij} = the combined value for month j and year i,

$HA1_{ij}$ = the monthly value for month j and year i from the first time series,

$HA2_{ij}$ = the monthly value for month j and year i from the second time series,

A = a multiplier for the first series (supplied by the user), and

B = a multiplier for the second series (supplied by the user).

The coefficients A and B are any values the user elects to use.

COMMTS has at least two conceptual uses. First, it may be used as the most elementary of networking programs. For example, two habitat time series files resulting from HABTS may be adjusted for segment length and summed. This will allow you to convert from WUA (ft^2/1,000 ft) to total habitat (ft^2) by multiplying each segment's WUA by its respective reach length. For example, Segment A is 10 miles long and Segment B is 20 miles long. Entering weights of 52.8 (5.28 × 10) and 105.6 would allow you to calculate total habitat in square feet.

The second use of COMMTS would be to combine sets of flow time series data. With weights equal to one, simple tributary addition can be performed. With weights unequal to one, scaling flows can occur. For example, one data set may be the current flow time series. You might add, or subtract, from the current flows a set of flows—for instance, Q—representing a proposed alternative. Scaling that Q set may allow fine tuning of the alternative.

Running COMMTS

RCOMMTS, ZMTS1, ZMTS2, ZMTSN

ZMTS1 = Monthly time series file in USGS format; can be a multirecord file (input).

ZMTS2 = Monthly time series file in USGS format; can be a multirecord file (input).

ZMTSN = Combined monthly time series file in USGS format (output).

The title lines from the two sets of data will be displayed, and then the following:

```
PROGRAM COMBINES TWO SETS OF DATA USING THE EQUATION-

        D3 = A*D1 + B*D2

ENTER A AND B:
```

The user would enter coefficients for A and B here.

```
ENTER TWO LINE TITLE FOR COMBINED FILE:

ENTER STATION ID (8 CHARS MAX):
```

GET1 Program

Introduction

The GET1 program extracts records from a multirecord file. GET1 is useful for a variety of tasks such as the extraction of a single life stage's habitat time series from the file created by HABTS.

In this context, a multirecord file is one that begins with a 7-character record name and ends with #EOR, as opposed to a multirecord ZHAQF file where records are separated by a line of at least 10 asterisks (**********).

```
CLASSA1
SNOQUALMIE RIVER
   FRY      RAINBOW TROUT
12142000     1971 1     16894  14585  16598  12035  12444  16865

12142000     1971 2     15501   8019   9006  10400  17841  17452

12142000     1972 1     16294  12313  15399  15073  11639   9344

12142000     1972 2     12353   8409   8325  12460  18655  15320

12142000     1973 1     17872  16138  13202  16229  18966  19033

12142000     1973 2     17418  14164  14600  17977  17492  17434

#EOR
CLASSA2
SNOQUALMIE RIVER
   JUVENIL  RAINBOW TROUT
12142000     1971 1     11761  12041  11761  10643  12995  12959
```

This format has the following requirements:

1. The record names must be 1 to 7 characters, constructed with the characters a–z, A–Z, and 0–9. Other characters may be legal for MS-DOS applications but will not be legal for CDC implementations. The record name will be the first 7 characters on the first line.
2. The end-of-record marks may be either #EOR or #eor and must be the first 4 characters on a line. This special end-of-record mark is required so that transfer of this data file using the CDC CONNECT software from microcomputers to CDC mainframes will work properly. Conversely, a standard CDC multirecord data file will contain these same characters if transferred from the mainframe to micro using CONNECT. CONNECT is a copyrighted program available for free distribution to CDC users.
3. The data contained in the text data must be standard ASCII lines less than or equal to 32,767 characters in length, terminated by a carriage return–line feed sequence. (To conform to CDC standards, however, we recommend that a line be no longer than 136 characters.) Any ASCII editor will create such a file.

Running GET1

RGET1, ZIN, ZOUT

ZIN = Multirecord file (input).

ZOUT = File with selected records (output).

```
THE INPUT FILE: [—]
CONTAINS THE FOLLOWING RECORDS:
```

Example:

1: classA1
2: classA2
3: classA3

```
ENTER HOW MANY RECORDS TO EXTRACT:

ENTER THE CORRESPONDING NUMBERS OF THE [—]
RECORDS IN ORDER:
```

For example, if classA2 and classA3 are to be extracted, 2 would have been entered for the number of records to extract and the numbers 2 and 3 would be entered for the record numbers.

The records will be copied to a data file with the name specified when the program was run. If no name was specified, the filename will be ZOUT.

LPTDUR Program

Introduction

The LPTDUR program reads one or two monthly time series files and creates an output file arranged either by groups of months or by individual months. The output contains annual duration tables showing ordered monthly data for each group of months or for each individual month of the year, an exceedence plot for each month or group of months, or a summary statistics table showing average, median, index-A (average of the interval between 50% duration and 90% duration), index-B (average of the interval between 10% duration and 90% duration), index-C (a user-defined index), 10%, 20%, 80%, 90% exceedence, and plots showing median, average, change in median, and change in average for the two data sets.

Grouping by sets of months is useful for characterizing habitat values for a life stage that is only present for a few months. Grouping by individual months is useful for fine tuning flow recommendations on a month by month basis.

Running LPTDUR

RLPTDUR, ZOUT, ZMTS, ZMTS2

ZOUT = LPTDUR results (output).

ZMTS = Monthly time series file in USGS or NWDC format (input).

ZMTS2 = Second monthly time series file in USGS or NWDC format (input).

> Note: Input files do not have to be in the same format or contain the same number of years; however, they must begin with the same month. Input files may be multirecord.

```
ENTER:    0 TO LIST INFORMATION BY GROUP OF MONTHS
          1 TO LIST INFORMATION BY INDIVIDUAL MONTHS
```

The output file will either be arranged by a group of months for each year or by each individual month for each year. If you choose "Group of months", you will later be prompted to enter the first and last valid months for the group of months of data to be included in this run. The output contains annual duration tables showing ordered monthly data for each month or group of months for each year.

```
ENTER TABLE LABEL FOR FIRST SET (UP TO 14 CHAR):
```

The program will display the first two lines of the first data set for user identification. The label should identify the data set and will appear on the output tables. If two data sets were specified as input, the same prompt will appear for the second data set.

```
ENTER INDEX FOR FIRST MONTH OF DATA (FEB.=2, ETC.):
```

This index will label the first data entry on the input data file(s) with the corresponding month name. For example, if the first entry on the data file(s) is January, enter 1. If the first entry on the data file(s) is October, enter 10.

> Note: If two input files were specified, they must both begin with the same month.

If option 0 was selected to list information by group of months, the following prompt will appear:

```
ENTER INDEX FOR FIRST AND LAST VALID MONTHS (SEP.=9, ETC.)
```

The user must designate the series of consecutive months of data to be included for this run. For example, entering 6 and 10 will plot and display only June through October in each year.

If option 1 was selected to list information by individual months, the following prompt will appear:

```
ENTER    1 TO PLOT SUMMARY RESULTS, 0 OTHERWISE.
```

If 1 is entered, the index-A, index-B, index-C, median, and average monthly summary statistics will be plotted.

```
LPTDUR WILL COMPUTE INDEX-A (50%-90%) AND INDEX-B
(10%-90%)
ENTER    1 TO DEFINE AN INDEX-C, 0 OTHERWISE.
```

Index-C may be useful if the exceedence values described by index-A and index-B are irrelevant to your application or do not cover the percentages of interest. For example, if the events in the 90–100% exceedence category are thought to be important population limiting events, then you may wish to define index-C as covering the 90–100% exceedence category.

If 1 is entered to define an Index-C:

```
ENTER THE LOWER AND UPPER BOUNDARIES FOR INDEX-C:

ENTER    1 TO WRITE DURATION TABLE(S), 0 OTHERWISE.
```

These are tables showing ordered monthly data either by individual months or groups of months depending on the option selected.

```
ENTER    1 FOR DURATION PLOT(S), 0 OTHERWISE.
```

These are monthly (or by groups of months) exceedence plots.

If tables or plots are to be written:

```
ENTER PLOT AND DURATION TABLE TITLE LINE (UP TO 70 CHARACTERS):
```

This title will appear below the X-axis on plots and above each duration table.

```
ENTER  1 FOR LOG-LINEAR PLOT, 0 FOR LINEAR-LINEAR.
```

The Y-axis will represent the data values. Enter 1 for the X-axis on a log scale or 0 for the X-axis on a linear scale.

The following prompt will appear if the linear–linear plotting option is chosen. For log–linear, the X-axis will automatically begin at the minimum X data value.

```
ENTER   0 FOR X-AXIS TO BEGIN AT 0
ENTER   1 TO BEGIN AT MINIMUM X-DATA VALUE

ENTER X-AXIS LABEL (UP TO 10 CHARACTERS)
```

This X-axis label will appear on the exceedence plot. The label should describe the type of input data and possibly the units.

Figure 8.5 contains sample output from the LPTDUR program.

```
DATE - 90/06/05.     SNOQUALMIE RIVER                                  PROGRAM - LPTDUR
TIME - 11.58.49.       FRY      RAINBOW TROUT                              PAGE -     1


FIRST DATA SET IS -

SNOQUALMIE RIVER
   FRY      RAINBOW TROUT
```

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1971	16894.00	14585.00	16598.00	12035.00	12444.00	16865.00	15501.00	8019.00	9006.00	10400.00	17841.00	17452.00
1972	16294.00	12313.00	15399.00	15073.00	11639.00	9344.00	12353.00	8409.00	8325.00	12460.00	18655.00	15320.00
1973	17872.00	16138.00	13202.00	16229.00	18966.00	19033.00	17418.00	14164.00	14600.00	17977.00	17492.00	17434.00
1974	15879.00	14592.00	10831.00	12325.00	15749.00	13271.00	11672.00	10222.00	7804.00	10121.00	18474.00	17152.00
1975	18218.00	14871.00	13755.00	13843.00	15871.00	16687.00	18945.00	9960.00	9786.00	14472.00	17169.00	17229.00
1976	14953.00	11717.00	10860.00	11302.00	17715.00	18909.00	14929.00	10597.00	12494.00	14811.00	18238.00	17802.00
1977	16681.00	16269.00	16253.00	16897.00	17474.00	17980.00	13293.00	13607.00	15855.00	17876.00	17495.00	17694.00
1978	17725.00	11887.00	12576.00	16373.00	17150.00	16754.00	16876.00	13973.00	16614.00	18622.00	17352.00	16031.00
1979	17986.00	15351.00	16165.00	18184.00	14082.00	14780.00	14224.00	10697.00	15320.00	17188.00	16979.00	17094.00
1980	17148.00	17548.00	11464.00	17626.00	14897.00	17149.00	12386.00	15392.00	15625.00	18762.00	16667.00	16649.00
1981	17381.00	12436.00	10624.00	18758.00	13237.00	19253.00	12931.00	13102.00	11700.00	19105.00	16670.00	16783.00
1982	15170.00	16546.00	14496.00	14170.00	12447.00	15264.00	16186.00	10901.00	10577.00	16605.00	17271.00	16979.00

```
SECOND DATA SET IS -

DATE - 90/06/05.       SNOQUALMIE RIVER                                PROGRAM - LPTDUR
TIME - 11.58.49.         FRY      RAINBOW TROUT                            PAGE -     2


MONTHLY HABITAT TIME SERIES ANALYSIS - 1971-82

              ORDERED MONTHLY DATA FOR JUN THRU OCT

                      PRE-PROJECT
```

ORDER NUMBER	YEAR	ELEMENT	PLOTTING POINT
1	1981	19105.00	0.83
2	1980	18762.00	2.50
3	1972	18655.00	4.17
4	1978	18622.00	5.83
5	1974	18474.00	7.50
6	1976	18238.00	9.17
7	1975	18218.00	10.83
8	1979	17986.00	12.50
9	1973	17977.00	14.17
10	1977	17876.00	15.83
11	1973	17872.00	17.50

Fig. 8.5. Sample output from the LPTDUR program. This output was generated using one input file and selecting the option to list information by group of months. June through October were the valid months. Tables and plots were both requested.

12	1971	17841.00	19.17
13	1976	17802.00	20.83
14	1978	17725.00	22.50
15	1977	17694.00	24.17
16	1977	17495.00	25.83
17	1973	17492.00	27.50
18	1971	17452.00	29.17
19	1973	17434.00	30.83
20	1981	17381.00	32.50
21	1978	17352.00	34.17
22	1982	17271.00	35.83
23	1975	17229.00	37.50
24	1979	17188.00	39.17
25	1975	17169.00	40.83
26	1974	17152.00	42.50
27	1980	17148.00	44.17
28	1979	17094.00	45.83
29	1979	16979.00	47.50
30	1982	16979.00	49.17
31	1971	16894.00	50.83
32	1981	16783.00	52.50
33	1977	16681.00	54.17
34	1981	16670.00	55.83
35	1980	16667.00	57.50
36	1980	16649.00	59.17
37	1978	16614.00	60.83
38	1982	16605.00	62.50
39	1972	16294.00	64.17
40	1978	16031.00	65.83
41	1974	15879.00	67.50
42	1977	15855.00	69.17
43	1980	15625.00	70.83
44	1979	15320.00	72.50
45	1972	15320.00	74.17

Duration table terminated for brevity.

DATE - 90/06/05. SNOQUALMIE RIVER PROGRAM - LPTDUR
TIME - 11.58.49. FRY RAINBOW TROUT PAGE - 4

SUMMARY STATISTICS FOR JUN THRU OCT
PRE-PROJECT

AVERAGE =	15870.466	0.000
MEDIAN =	16936.500	0.000
INDEX-A =	15213.021	0.000
INDEX-B =	16352.300	0.000
INDEX-C =	14642.374	0.000 ***
10 PERCENT =	18228.000	0.000
20 PERCENT =	17821.500	0.000
80 PERCENT =	14705.500	0.000
90 PERCENT =	10488.500	0.000

*** INDEX-C IS THE AVERAGE PERCENTAGE EXCEEDENCE
BETWEEN: 50.00 AND 95.00

Fig. 8.5. *Continued.*

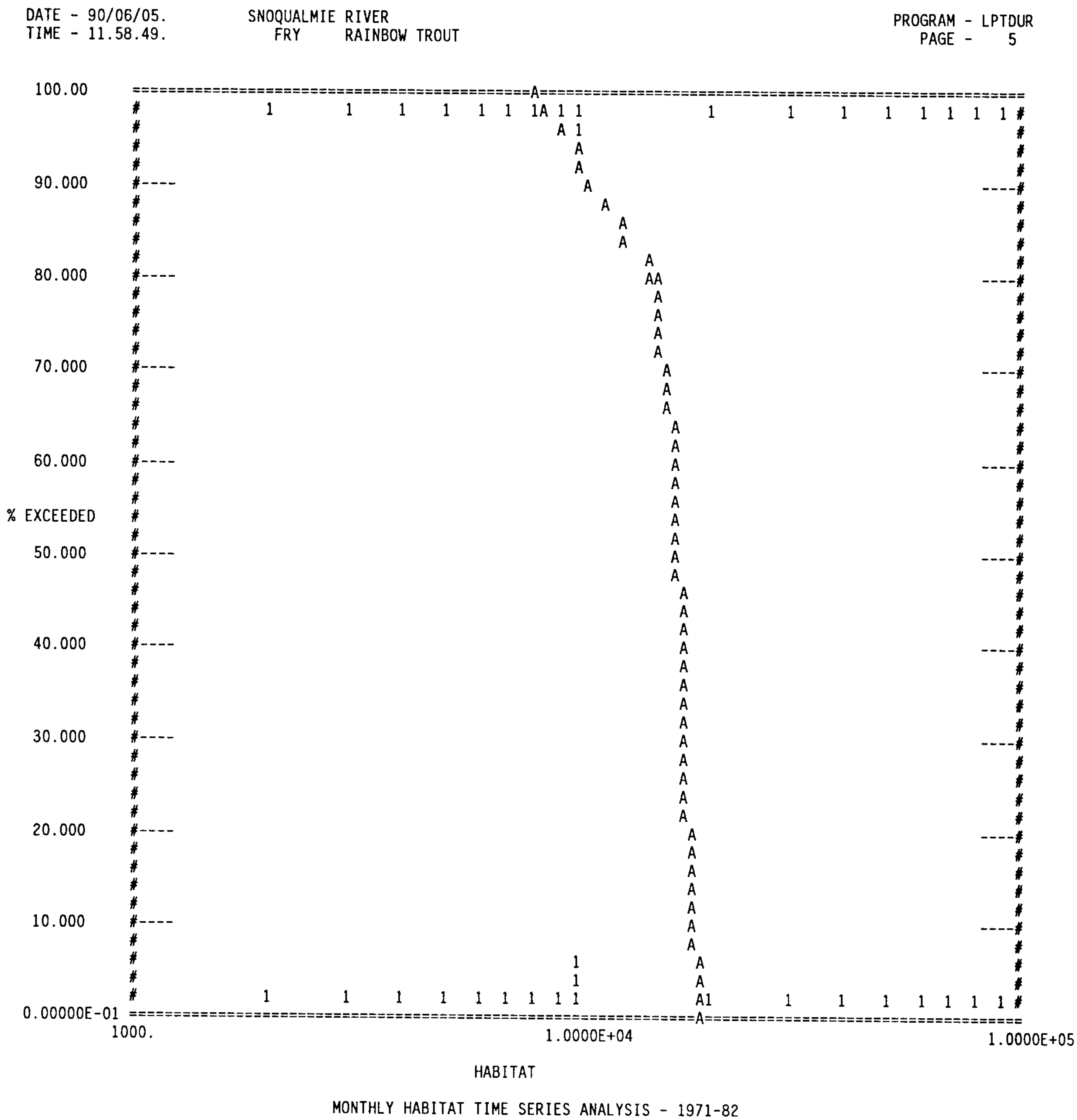


Fig. 8.5. *Continued.*

LPTQHA Program

Introduction

The LPTQHA program plots monthly habitat area or streamflow from one or two monthly time series files, approximately five years per page. The program has the option to plot the Y-axis using either a logarithmic or linear scale. If the minimum data value is less than the maximum data value divided by 50.0, then the Y-axis will be logarithmic.

Running LPTQHA

RLPTQHA, ZOUT, ZMTS, ZMTS2

ZOUT = LPTQHA results (output).

ZMTS = Monthly times series file in USGS or NWDC format (input).

ZMTS2 = Second monthly time series file in USGS or NWDC format (input).

> Note: Input files do not have to be in the same format or contain the same number of years; however, they must begin with the same month. Multi-record files may be used.

```
ENTER   1 IF INPUT DATA FILES CONTAIN FLOWS
ENTER   0 IF THEY CONTAIN HABITAT AREAS

ENTER   2 FOR LOG-LINEAR PLOT, 1 FOR LINEAR-LINEAR:
```

The X-axis will represent time, in months, on a linear scale.

The Y-axis will represent the data values.

Enter 2 for the Y-axis on a log scale or 1 for the Y-axis on a linear scale. If the minimum data value is less than the maximum data value divided by 50.0, then the Y-axis is logarithmic.

```
ENTER INDEX FOR FIRST MONTH OF DATA (OCT.=10, ETC.):
```

This index will label the first data entry on the input data file(s) with the corresponding month name. For example, if the first entry on the data file(s) is January, enter 1. If the first entry on the data file(s) is October, enter 10.

> Note: If two input files were specified, they must both begin with the same month.

```
ENTER FIRST MONTH AND LAST MONTH OF VALID MONTHS.
```

The user must designate the series of consecutive months of data to be included for this run. For example, entering 6 and 10 will plot and display only June through October in each year.

Figure 8.6 contains sample output from the LPTQHA program.

```
89/01/23.    H 12142000     47365412142440053533033SW17110010    64.00      1130.00              PROGRAM - LPTQHA
 17.45.12.   N 12142000       N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.                          PAGE    0

 EFFECTIVE FOR EACH GRAPH INDIVIDUALLY, THE PLOTTING
 SYMBOLS USED REPRESENT THE ORDER IN WHICH THE DATA WERE
 PLOTTED. THE ORDER IS ILLUSTRATED IN THE FOLLOWING EXAMPLE
 OF TWO DATA FILES, EACH CONTAINING 3 YEARS OF DATA:

 PLOTTING SYMBOL = A FOR VALID MONTHS OF YEAR 1, DATA FILE 1
 PLOTTING SYMBOL = B FOR VALID MONTHS OF YEAR 2, DATA FILE 1
 PLOTTING SYMBOL = C FOR VALID MONTHS OF YEAR 3, DATA FILE 1
 PLOTTING SYMBOL = D FOR VALID MONTHS OF YEAR 1, DATA FILE 2
 PLOTTING SYMBOL = E FOR VALID MONTHS OF YEAR 2, DATA FILE 2
 PLOTTING SYMBOL = F FOR VALID MONTHS OF YEAR 3, DATA FILE 2

 WHEN 2 OR MORE POINTS LIE ON TOP OF ONE ANOTHER, ONLY THE
 PLOTTING SYMBOL FOR THE LAST OF THE POINTS IS USED.
```

Fig. 8.6. Sample output from the LPTQHA program. This output was generated using one monthly habitat time series file as input—only the output for Rainbow trout—Fry, years 1971–75 has been included.

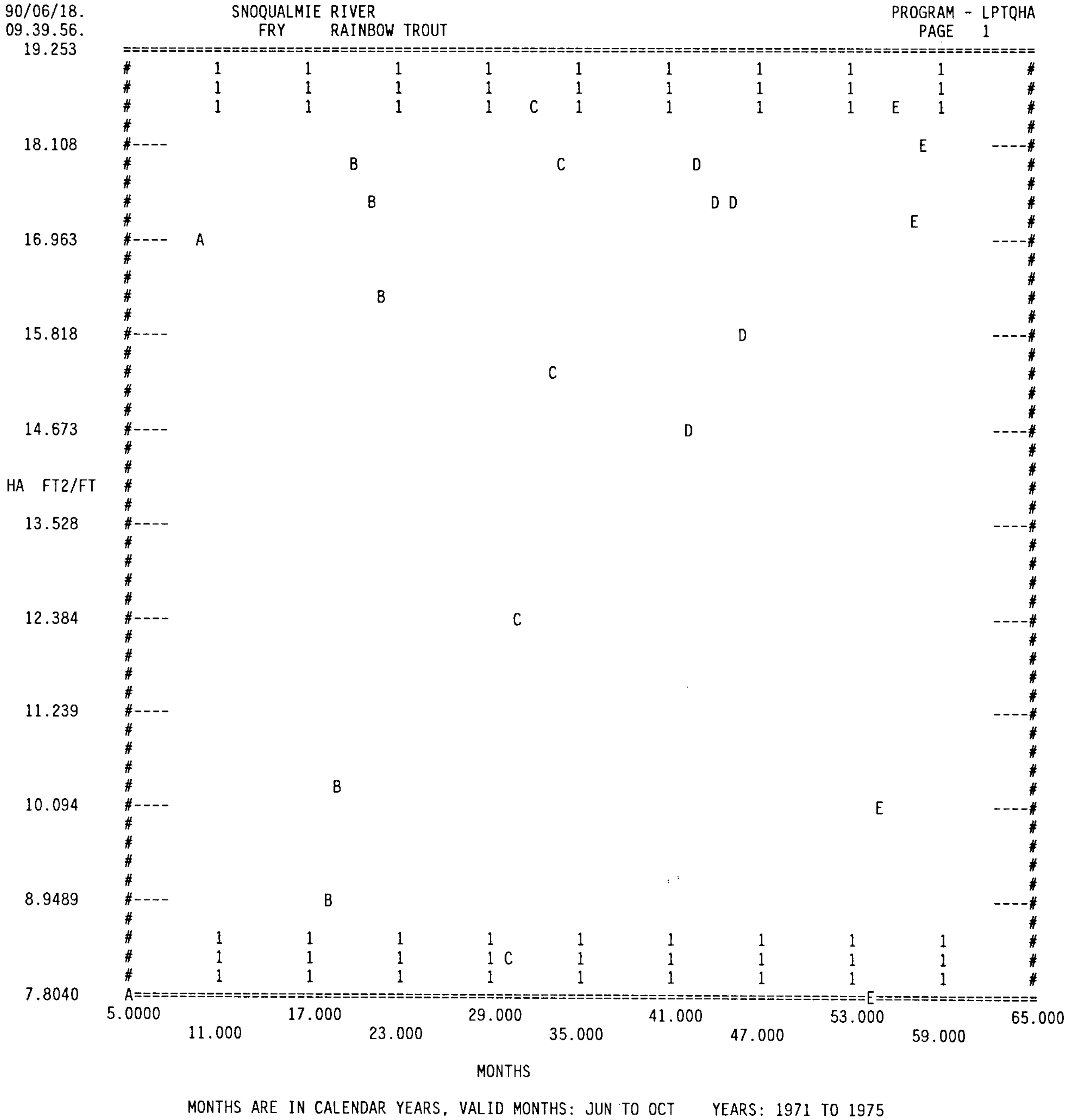


Fig. 8.6. *Continued.*

LPTTSN Program

Introduction

The LPTTSN program reads up to five monthly time series files in USGS or NWDC format and plots the data in a user-specified range of years. Output includes tables and plots. The plots can be displayed on the screen or written to the output file.

Running LPTTSN

RLPTTSN, ZOUT, ZMTS1, ZMTS2, ZMTS3, ZMTS4, ZMTS5

ZOUT = LPTTSN results (output).

ZMTS(1–5) = Monthly time series files in USGS or NWDC format (input).

> Note: Input files do not have to be in the same format or contain the same number of years; however, they must begin with the same month. Multi-record files cannot be used. The maximum permissible number of flow-versus-time data pairs is 1,200 (100 years of data).

The title lines from each of the input files will be displayed on the screen and you will be instructed to enter a <CR> to continue.

```
DISPLAY OPTIONS:
1-PRINT TABLES OF VARIABLE VALUES
2-80 COLUMN PRINTER PLOT
3-130 COLUMN PRINTER PLOT
4-QUIT

ENTER OPTION:
```

Specify if you want to print the monthly time series values in tabular form, print out an 80-column plot of the data, or print out a 130-column plot. Figure 8.7 contains sample output when option 1 (Print tables of variable values) is selected. Figure 8.8 is a 80-column printer plot (option 2).

```
ENTER   0 - DISPLAY TO MONITOR
   OR   1 - OUTPUT RESULTS TO COMPUTER FILE:
```

The program prompts for your choice of output destination. If you choose to display the output to the monitor, enter 0. If you want to produce a file on disk, enter 1. This will be the ZOUT filename specified previously.

```
ENTER PLOT OR TABLE TITLE, 80 CHAR:
```

Enter a title line of up to 80 characters for the output. The plots (or table if option 1 was selected to print tables of variable values) will be labeled with this title.

```
ENTER Y-AXIS LABEL OR COLUMN TITLE, 50 CHAR:
```

Enter a label for the Y-axis (dependent variable axis). If option was selected to print a table of variable values, this will be the column title.

```
YEARS IN FILE [——]
```

The active years in each of the input data files are displayed. After each input data file (or after each monitor screen full of years) the program will pause with a request to press a <CR> to continue the list.

```
ENTER BEGINNING AND ENDING YEARS TO BE PLOTTED:
```

These do not have to be the lowest and highest years in the data. If specified years are not in the data, the program will skip those years. Specify years by entering the years, separated by a comma, a carriage return, or one or more spaces.

If 1 was selected in the display options prompt "Print table of variable values," the following prompt will not appear. The program will return to the display options prompt.

```
ENTER Y-AXIS LOW AND HIGH SCALE VALUES
        OR 0,0 FOR DEFAULT SCALING AND STATISTICS
        OR -1,-1 FOR STATS ONLY
ENTER VALUES:
```

If you enter the low and high values, the program sets the lowest and highest bounds on the plots at those values. If the plot exceeds these limits, a "<" or ">" symbol appears on the graph to indicate that the value read from the input data files was less than or greater than the indicated limits, respectively.

If you want the program to scale the data from values read from the input data files, enter 0,0. The program will choose default values to cover the range in the data files. We recommend selecting this option.

If you enter –1, –1, then only the maximum and minimum values are displayed for each data input file. This is convenient if you want to avoid using the default values but are not aware of the range of values in the data. If you choose this option, the program will "cycle" back so you can reenter the low and high values for a plot.

```
N.F. SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS, WA (Table Title)

           Column Title
YEAR.MO      12142000
1930.01        118.68
1930.02        129.63
1930.03        511.29
1930.04        242.74
1930.05        980.32
1930.06        449.00
1930.07        539.23
1930.08        473.39
1930.09        398.17
1930.10        114.97
1930.11         45.00
1930.12         76.60
1931.01        491.74
1931.02        290.50
1931.03        259.58
1931.04        674.84
1931.05        397.57
1931.06        681.58
1931.07        576.97
1931.08        539.48
1931.09        520.20
1931.10        121.84
1931.11         52.42
1931.12        224.97
1932.01        467.19
1932.02        542.30
1932.03        407.65
1932.04        537.39
1932.05        626.48
1932.06       1071.00
1932.07        946.37
1932.08        883.68
1932.09        905.93
1932.10        483.45
1932.11        143.65
1932.12        171.00
```

Fig. 8.7. Sample output (table of variable values) from the LPTTSN program.

After you have specified the low and high values, the program will produce its major output and return to the Display options prompt. If you specified monitor output, the output data-plots are shown on the monitor. If you specified computer file output, all results from this session will be written to the filename specified when the program was initialized.

If display option 1, Print tables of variable values, is selected the output will consist of the same values read from the monthly time series files, written in tabular form. Columns of time series data are headed by the gaging station identifiers read from the input data files.

When Display option 2 (80-Column printer plot) or 3 (130-Column printer plot) is chosen, an 80- or 130-column plot is made to either the monitor display or computer disk file, depending on the user-selected output device. The first file specified is plotted as A, the second file as B, and so on. Figure 8.8 is an example of 80-column output.

```
          DATA MINIMA
   12142000
     45.00

          DATA MAXIMA
   12142000
   1071.00


SNOQUALMIE RIVER STUDY (Plot Title)
         MONTHLY MEAN DISCHARGE  (Y-Axis Label)
YEAR.MO
   3.00E+01      4.24E+02      8.18E+02      1.21E+03       1.61E+03    2.00E+03
 1930.00 +-------------+-------------+-------------+-------------+-------------+
 1930.01 + A
 1930.02 +  A
 1930.03 +               A
 1930.04 +      A
 1930.05 +                               A
 1930.06 +             A
 1930.07 +                A
 1930.08 +              A
 1930.09 +            A
 1930.10 + A
 1930.11 A
 1930.12 +A             +             +            +             +              +
 1931.01 +               A
 1931.02 +       A
 1931.03 +      A
 1931.04 +                     A
 1931.05 +            A
 1931.06 +                     A
 1931.07 +                  A
 1931.08 +                 A
 1931.09 +                A
 1931.10 + A
 1931.11 A
 1931.12 +     A        +             +            +             +              +
 1932.01 +               A
 1932.02 +                 A
 1932.03 +            A
 1932.04 +                 A
 1932.05 +                    A
 1932.06 +                                   A
 1932.07 +                                A
 1932.08 +                             A
 1932.09 +                              A
 1932.10 +               A
 1932.11 +  A
 1932.12 +   A          +             +            +             +              +
```

Fig. 8.8. Sample output (80-column printer plot) from the LPTTSN program. When two or more files are used as input, the station identifiers are aligned with their minimum and maximum data values. Overplots of data (where files have the same position in the plot) are shown by an asterisk (*). The "+" symbols are used as scale markings.

MTSLST Program

Introduction

The MTSLST program produces a formatted table of monthly time series values and their averages. These tables are useful for exporting to LOTUS or other application programs.

The MTSLST program requires one input file that lists 12 values for each year and generates 2 output files. One output file contains the average monthly and coefficient of variation values for the data set, and the other consists of the time series values listed monthly for each year as well as summary statistics.

MTSLST accepts a wide variety of input data file formats; however, it is restricted to data files containing a record identifier. The input files may be multirecord files. The following is a sample free-formatted file:

```
CLASSA1
UPPER MAIN STEM OF ST. VRAIN CREEK BELOW LYONS, COLORADO
   FRY  RAINBOW  TROUT
12345678 (8 digit station number)
1930
118.68  129.63  511.29  242.74  980.32  449.00
539.23  473.39  398.17  114.97   45.00   76.60
1931
        ... (more data here) ...

946.37  883.68  905.93  483.45  143.65  171.00
#EOR
```

Running MTSLST

RMTSLST, ZMTS, OUTMON, OUTAVG

ZMTS = Monthly time series file; can be multirecord (input).

OUTMON = Table of time series data listed monthly for each year (output).

OUTAVG = Table of average monthly and coefficient of variation values (output).

```
ENTER INDEX TO FIRST MONTH OF DATA (JAN.=1, OCT.=10, ETC.)
```

Enter the number of the month of the year. For example, entering "10" would indicate that the first month of input data is October.

```
ENTER UNITS (10 CHAR)
```

This prompt is asking for the units to be given to the data being input. This will appear in the output file with the data. Example: CFS, SQFT/1000', etc.

```
SEVEN FORMATS FOR THE MONTHLY DATA ARE AVAILABLE.
ENTER  1 FOR (10X,I4,1X,12F5.0),
       2 FOR (10X,I4,1X,12F5.2),
       3 FOR NWDC FORMAT,
       4 FOR (5X,I4,1X,12F5.1),
       5 FOR (11X,I4,1X,F5.1),
       6 FOR USGS FORMAT
       7 FOR FREE FORMAT.
```

There are several choices for the format of the input. Each one will be briefly described by way of FORTRAN format statement syntax. As a sample interpretation, 10X, I4, 1X, 12F5.2 would be a line with 10 blanks (10X), an integer of length 4 (I4), another space (1X), and 12 floating point numbers of length 5 including 2 to the right of the decimal point (12F5.2).

```
FOUR FORMATS CAN BE USED FOR LISTING OF TIME SERIES
DATA.

ENTER   0 FOR XXX
        1 FOR XXX.X
        2 FOR XXX.XX
        3 FOR LOTUS MULTIPLE COLUMNS
        4 FOR LOTUS SINGLE COLUMN WITH NO TITLES AND
             NO SUMMARY STATISTICS.
```

The output can be listed with various digits being allowed to the right of the decimal point (illustrated by x's in place of variable digits) or in two different Lotus 1-2-3 formats.

The program then lists the names of the stations for the data analyzed and how many stations were reviewed.

Figure 8.9 contains sample output from OUTMON file in Lotus multiple-columns format; Fig. 8.10 contains sample output from the OUTAVG file in Lotus multiple-columns format. The sample ZMTS file in Appendix A was used as input.

```
'90/05/23.          SNOQUALMIE RIVER                                                    PROGRAM - MTSLST"
"13.50.48.              FRY      RAINBOW TROUT                                              PAGE -  1"


 1971    1  16894.00
 1971    2  14585.00
 1971    3  16598.00
 1971    4  12035.00
 1971    5  12444.00
 1971    6  16865.00
 1971    7  15501.00
 1971    8   8019.00
 1971    9   9006.00
 1971   10  10400.00
 1971   11  17841.00
 1971   12  17452.00
 (sample terminated)


'90/05/23.          SNOQUALMIE RIVER                                                    PROGRAM - MTSLST"
"13.50.48.              FRY      RAINBOW TROUT                                              PAGE -  2"


     'STATION ID:   142000

  " NO. OF YEARS:  12

    'RECORD NAME: CLASSA1

           'AVERAGE MONTHLY RATE

   "J   MONTH    sqft/1000'   COEF. OF VARIATION     MAXIMUM      MINIMUM
    1     OCT  16850.08400              0.06188     18218.00     14953.00
    2     NOV  14521.08300              0.13153     17548.00     11717.00
    3     DEC  13518.58300              0.16035     16598.00     10624.00
    4     JAN  15234.58300              0.15757     18758.00     11302.00
    5     FEB  15139.25000              0.15163     18966.00     11639.00
    6     MAR  16274.08300              0.16654     19253.00      9344.00
    7     APR  14726.16700              0.14981     18945.00     11672.00
    8     MAY  11586.91700              0.19739     15392.00      8019.00
    9     JUN  12308.83300              0.24960     16614.00      7804.00
   10     JUL  15699.91700              0.19673     19105.00     10121.00
   11     AUG  17525.25000              0.03599     18655.00     16667.00
   12     SEP  16968.25000              0.03998     17802.00     15320.00
```

Fig. 8.9. Sample output (OUTMON file) from the MTSLST program.

```
SNOQUALMIE RIVER
   FRY      RAINBOW TROUT
 MEAN MONTHLY VALUES AND COEFF OF VARIATION IN sqft/1000'
* 1    OCT    16850.08      0.062
* 2    NOV    14521.08      0.132
* 3    DEC    13518.58      0.160
* 4    JAN    15234.58      0.158
* 5    FEB    15139.25      0.152
* 6    MAR    16274.08      0.167
* 7    APR    14726.17      0.150
* 8    MAY    11586.92      0.197
* 9    JUN    12308.83      0.250
*10    JUL    15699.92      0.197
*11    AUG    17525.25      0.036
*12    SEP    16968.25      0.040
#EOR
SNOQUALMIE RIVER
   JUVENIL RAINBOW TROUT
 MEAN MONTHLY VALUES AND COEFF OF VARIATION IN sqft/1000'
* 1    OCT     9109.67      0.207
* 2    NOV    11496.58      0.154
* 3    DEC    12206.67      0.080
* 4    JAN    11344.25      0.125
* 5    FEB    12138.17      0.112
* 6    MAR    12547.83      0.094
* 7    APR    13647.33      0.051
* 8    MAY    13201.00      0.119
* 9    JUN    12899.92      0.112
*10    JUL    11073.92      0.211
*11    AUG     8143.83      0.230
*12    SEP     8679.33      0.236
#EOR
SNOQUALMIE RIVER
   ADULT    RAINBOW TROUT
 MEAN MONTHLY VALUES AND COEFF OF VARIATION IN sqft/1000'
* 1    OCT     6796.58      0.258
* 2    NOV     9309.25      0.195
* 3    DEC    10065.67      0.087
* 4    JAN     8987.58      0.160
* 5    FEB     9683.00      0.129
* 6    MAR     9760.33      0.123
* 7    APR    11176.83      0.090
* 8    MAY    11549.75      0.088
* 9    JUN    11089.42      0.079
*10    JUL     8775.50      0.303
*11    AUG     5819.08      0.257
*12    SEP     6369.75      0.278
#EOR
```

Fig. 8.10. Sample output (OUTAVG file) from the MTSLST program.

MULMTS Program

Introduction

The MULMTS program multiplies all data in a monthly time series file in USGS or NWDC format by a constant. The output file is in the same format as the input file.

One example of the use of the MULMTS program would be to calculate total habitat. In this case, you would multiply the WUA (ft^2/1,000 ft) by the reach length in miles to obtain total square feet.

Running MULMTS

RMULMTS, ZMTS, ZMTSN

ZMTS = Monthly time series file in USGS or NWDC format; can be a multirecord file (input).

ZMTSN = New monthly time series file after multiplication (output).

The title lines from the input file will be displayed. This will help to verify that the correct file is being multiplied.

```
ENTER MULTIPLIER
```

Enter the value by which you want the entries to be multiplied. For example, if 2 is entered, the values in the input file will be doubled in the output file.

The record numbers in the input file will be displayed as they are being multiplied.

Example:

WORKING ON—CLASSA1
WORKING ON—CLASSA2
WORKING ON—CLASSA3
WORKING ON—CLASSA4

On completion of the run, you will be told how many records were multiplied by the given value.

```
[-] RECORDS MULTIPLIED BY [    .        ]
```

SCORTS Program

Introduction

The SCORTS program reads a monthly time series file and calculates several statistical parameters, including log normal distributions and lag one correlation coefficients.

Either USGS or NWDC formatted files may be used as input to SCORTS. When streamflow is contained in the input file, it is assumed that discharge (Q) is in cubic feet per second (cfs) and that the flows are ordered by month.

Running SCORTS

RSCORTS, ZMTS, ZOUT, ZANTS

ZMTS = Monthly time series file in USGS or NWDC format; can be a multirecord file (input).

ZOUT = SCORTS results (output).

ZANTS = Average of 12 monthly values for each year (output).

Figure 8.11 contains sample output from the ZANTS file from the SCORTS program; Fig. 8.12 contains output from the ZOUT file.

The ZOUT file contains all monthly and annual calculations determined by SCORTS. This output assumes that streamflow was used as input.

1. A listing of monthly values with each year's annual total in cfs.
2. A log–normal distribution for the data set, listing monthly distributions for this sample, where Q_n is the discharge not exceeded *n* percent of the years (i.e., Q50, $n = 50$, discharge not exceeded 50% of the years [median]). Also, Q50 – Q10 is the difference between the median discharge and the discharge not exceeded 10% of the years. This gives some idea as to the water available for allocation between alternative uses (i.e., instream flow uses).
3. A variety of statistical parameters are listed, such as the mean monthly discharge, monthly coefficient of variation, and the monthly standard deviation. The number of years in the data set is the sample size. Both an arithmetic and a logarithmic set of these parameters are calculated, where the logarithmic values are determined by first taking the log base 10 of each monthly flow then applying the statistical operations. The logarithmic terms make it possible for the user to fit distribution, other than the log–normal, to the data. The coefficient of variation compares the relative amounts of variation in populations having different means and is the standard deviation expressed as a percent of the mean. Also, the skew is calculated, indicating if the curve is a normal distribution or if either tail of the curve is drawn out more than the other. A positive skew means that there is a tail toward higher values and the median is less than the mean. A negative skew means that there is a tail toward the smaller values and the median is greater than the mean.
4. A lag one correlation coefficient is where the values denote how the flows in the previous month correlate with those of the present month. If the coefficient is close to one, then knowledge of flows in previous months tells us the flow for the present month. If the coefficient is zero, the flows in the two months are independent events. (For further explanation of the lag one correlation coefficient refer to Box and Jenkins 1976.)

```
NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH                1214200000
MEAN MONTHLY DISCHARGE - 1962 THRU 1977
AQ12142000  1962         481.7
AQ12142000  1963         421.4
AQ12142000  1964         601.0
AQ12142000  1965         497.4
AQ12142000  1966         436.9
AQ12142000  1967         518.4
AQ12142000  1968         600.8
AQ12142000  1969         534.8
AQ12142000  1970         429.5
AQ12142000  1971         588.6
AQ12142000  1972         735.6
AQ12142000  1973         363.4
AQ12142000  1974         664.4
AQ12142000  1975         509.7
AQ12142000  1976         627.8
AQ12142000  1977         358.5
```

Fig. 8.11. Sample output (ZANTS file) from the SCORTS program.

90/05/29. NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH 1214200000 PROGRAM - SCORTS
15.58.11. MEAN MONTHLY DISCHARGE - 1962 THRU 1977 PAGE 1

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	ANNUAL
1962	523.0	479.0	715.0	865.0	363.0	243.0	709.0	510.0	568.0	318.0	281.0	197.0	481.7
1963	300.0	721.0	748.0	421.0	686.0	314.0	523.0	456.0	394.0	247.0	125.0	149.0	421.4
1964	315.0	751.0	549.0	668.0	380.0	412.0	533.0	846.0	1219.0	692.0	439.0	405.0	601.0
1965	365.0	568.0	742.0	920.0	771.0	329.0	637.0	587.0	461.0	222.0	146.0	243.0	497.4
1966	352.0	475.0	429.0	543.0	275.0	472.0	666.0	798.0	599.0	424.0	120.0	78.0	436.9
1967	405.0	605.0	999.0	1054.0	572.0	389.0	284.0	747.0	771.0	244.0	71.0	73.0	518.4
1968	760.0	488.0	996.0	853.0	917.0	428.0	479.0	682.0	705.0	221.0	238.0	462.0	600.8
1969.	578.0	736.0	603.0	732.0	201.0	408.0	625.0	1013.0	764.0	249.0	90.0	401.0	534.8
1970	413.0	377.0	498.0	713.0	545.0	391.0	523.0	540.0	536.0	182.0	90.0	359.0	429.5
1971	364.0	589.0	480.0	938.0	834.0	397.0	444.0	1054.0	875.0	717.0	177.0	208.0	588.6
1972	374.0	788.0	537.0	651.0	1125.0	1250.0	682.0	1170.0	998.0	733.0	181.0	369.0	735.6
1973	171.0	392.0	972.0	577.0	219.0	275.0	353.0	523.0	493.0	162.0	64.0	145.0	363.4
1974	431.0	574.0	805.0	1105.0	453.0	670.0	620.0	877.0	1338.0	725.0	263.0	92.0	664.4
1975	51.0	528.0	768.0	919.0	439.0	428.0	279.0	854.0	802.0	564.0	307.0	163.0	509.7
1976	518.0	962.0	1556.0	996.0	343.0	244.0	480.0	785.0	645.0	491.0	323.0	157.0	627.8
1977	153.0	388.0	485.0	500.0	325.0	332.0	605.0	535.0	439.0	142.0	141.0	262.0	358.5

90/05/29. NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH 1214200000 PROGRAM - SCORTS
15.58.11. MEAN MONTHLY DISCHARGE - 1962 THRU 1977 PAGE 2

LOG-NORMAL DISTRIBUTION

MONTH	Q90	Q67	Q50	Q33	Q10	Q50-Q10
1	747.8	433.4	329.1	249.9	144.8	184.3
2	808.1	639.4	568.2	504.9	399.5	168.7
3	1092.5	812.1	699.2	602.0	447.5	251.7
4	1082.6	848.7	750.6	663.9	520.5	230.2
5	901.6	582.9	467.8	375.3	242.7	225.1
6	663.9	473.2	398.9	336.3	239.7	159.2
7	741.1	577.0	508.6	448.2	349.0	159.6
8	1043.4	815.4	720.0	635.7	496.8	223.2
9	1078.9	795.5	682.1	584.8	431.2	250.9
10	713.1	435.0	338.9	264.1	161.1	177.8
11	344.3	210.5	164.2	128.1	78.3	85.9
12	432.4	260.5	201.7	156.2	94.1	107.6
ANNUAL	670.3	560.9	512.6	468.5	392.0	120.6

STATISTICAL PARAMETERS

	ARITHMETIC			LOGARITHMIC			
MONTH	QMEAN	COEF. VAR.	STD DIV	XMEAN	COEF. VAR.	VARIANCE	SKEW
1	379.6	0.491	186.4	2.51731	0.11046	0.07732	-1.80239
2	588.8	0.282	166.1	2.75449	0.04332	0.01424	0.15990
3	742.6	0.388	288.0	2.84461	0.05314	0.02285	0.62838
4	778.4	0.246	191.6	2.87543	0.04314	0.01539	-0.53946
5	528.0	0.514	271.4	2.67002	0.08326	0.04943	0.04197
6	436.4	0.549	239.5	2.60087	0.06635	0.02978	1.59841
7	527.6	0.261	137.9	2.70634	0.04714	0.01627	-1.05466
8	748.6	0.286	213.7	2.85730	0.04399	0.01580	0.00256
9	725.4	0.309	224.0	2.83382	0.05482	0.02413	0.35356
10	395.8	0.551	218.1	2.53013	0.09958	0.06348	0.12665
11	191.0	0.846	161.6	2.21533	0.11322	0.06291	-0.03853
12	235.2	0.700	164.5	2.30473	0.11209	0.06674	-0.29397
ANNUAL	523.1	0.453	237.1	2.70981	0.03353	0.00826	-0.16909

LAG ONE CORRELATION COEFFICIENTS

MONTH	LOG	ARITHMETIC
1	0.14	0.02
2	0.27	0.22
3	0.28	0.37
4	0.42	0.47
5	0.19	0.13
6	0.41	0.53
7	0.20	0.28
8	0.00	0.05
9	0.76	0.82
10	0.75	0.97
11	0.61	0.39
12	0.20	0.09

SAMPLE SIZE: 16 YEARS
STATION ID: 12142000

Fig. 8.12. Sample output (ZOUT file) from the SCORTS program.

SELMTS Program

Introduction

The SELMTS program allows selection of individual months or groups of months from two or more monthly time series data files to create a single, composite monthly time series file.

Suppose, for example, you had three sets of habitat criteria for adults—one covering summer (ADULTSUM), one for winter (ADULTWIN), and one for spring and fall (ADULTS-F). The HABTAE program has produced three habitat-versus-flow files and so the HABTS or HABNET program has, in turn, generated three monthly time series files. However, only certain months from each file are valid. SELMTS is a way of selecting the appropriate months from each of the three files with a resultant single time series file that represents adults all year.

Running SELMTS

RSELMTS, ZMTSN, ZMTS

ZMTSN = New monthly time series file in the same format as the input files (output).

ZMTS = A base monthly time series file to be used as a building block; can be multirecord (input).

> Note: User will be prompted to enter filenames for other ZMTS files to select months from. All input files must be in the same format (USGS or NWDC), contain the same number of years, and begin with the same month.

You will be given a brief explanation of what the program is designed to do and how input files are treated; then you will be instructed to press <CR> to continue.

The title lines of the base monthly time series file to be used as a building block will be displayed to verify that this is the correct file. This filename was specified when the program was initiated.

```
ENTER TWO TITLE LINES FOR THE NEW FILE:
```

Enter two title lines for the output file.

```
ENTER INDEX FOR FIRST MONTH ON DATA SET (2=FEB., ETC.)
(OR H FOR HELP):
```

This index will label the first data entry on the input data file(s) with the corresponding month name. For example, if the first entry on the data file(s) is January, enter 1. If the first entry on the data file(s) is October, enter 10.

A table like the one below will appear to show what SELMTS will use as a yearly set-up. A help screen is also available.

Example:

Enter index for first month on data set (2 = Feb., etc.): 10

Month	O	N	D	J	F	M	A	M	J	J	A	S
ADULTSUM	X	X	X	X	X	X	X	X	X	X	X	X

```
SELECT MONTHS FROM FILES:
1-HELP
2-ENTER FILE NAME FROM WHICH TO SELECT MONTHS FROM
3-QUIT SELECTING MONTHS FROM FILES
  AND CREATE NEW FILE
ENTER OPTION:
```

If 2 is selected, the following prompt will appear. Remember: All files must be in the same format, contain the same number of years, and begin with the same month.

```
ENTER NAME OF FILE TO SELECT MONTHS FROM:
```

This file is one from which you wish to select values to substitute for those in the base file.

```
ON LINE UNDER THE MONTH(S) YOU WANT TO USE FROM FILE [——]
ENTER AN X (or enter H for help)
```

To select which month(s) to use from the input file specified, enter x or X *directly* beneath the desired months. Typing H will give a further description of this step and then return you to this point for selection of month(s). Any entry besides x, X, h, or H will be ignored. Do *not* use the TAB key or arrows to move between months—*do* use the space bar to guarantee proper information entry.

After selection of months from the current input file, you will be shown a summary of the base file, input files, and months chosen from each up to this point to ensure it is what you want. If two or more files have an x in a common month, the last one on this list will be used. This is one way to overcome an error in the input without starting over.

The preceding prompt will be asked again. Answer it according to your needs and continue as directed on the screen.

Example:

On line under the month(s) you want to use from file ADULTWIN enter an X (or enter H for help)

Month	O	N	D	J	F	M	A	M	J	J	A	S
ADULTSUM	X	X	X	X	X	X	X	X	X	X	X	X
ADULTWIN			X	X	X	X						

Month	O	N	D	J	F	M	A	M	J	J	A	S
ADULTSUM	X	X	X	X	X	X	X	X	X	X	X	X
ADULTWIN			X	X	X	X						

Select months from files:

1—Help,

2—Enter file name to select months from

3—Quit selecting months from files and create new file.

Enter option: 2

Enter name of file from which to select months:

ADULTF-S

On line under the month(s) you want to use from file ADULTF-S enter an X (or enter H for help)

Month	O	N	D	J	F	M	A	M	J	J	A	S
ADULTSUM	X	X	X	X	X	X	X	X	X	X	X	X
ADULTWIN			X	X	X	X						
ADULTF-S	X	X					X	X				

Month	O	N	D	J	F	M	A	M	J	J	A	S
ADULTSUM	X	X	X	X	X	X	X	X	X	X	X	X
ADULTWIN			X	X	X	X						
ADULTF-S	X	X					X	X				

Select months from files:

1—Help,

2—Enter file name to select months from

3—Quit selecting months from files and create new file.

Enter option: 3.

Chapter 9. Generation, Analysis, and Display of the Time Series of Annual Habitats

Introduction

The programs used to develop an annual habitat time series are based on the monthly time series of physical habitats. There are three approaches to using annual habitats: first, the use of the annual adult habitat time series for each life stage. This approach assumes that the time series for adults represents the year-to-year variation of the worth of the stream for a species of aquatic animal. The second approach is the use of the annual *equivalent* adult habitat time series. This approach assumes that each year is independent of the preceding year, but that each life stage must be considered. The third is the use of annual *effective* adult habitat time series. This approach does not assume that each year is independent of the preceding year.

The use of the annual adult habitat time series makes the assumption that the changes in the adult physical habitat are the habitat values to use in the comparison of the changes in the habitat resulting from changes in water management. This assumption is reasonable when the habitat for life stages other than adults is relatively larger than the habitat for adults. The ANNTS program is used to calculate the annual adult habitat time series from monthly habitats.

The second approach, using *equivalent* adult habitat, is useful when the analyst is uncertain about the year-to-year interactions. The *equivalent* adult habitat is based on monthly habitats calculated using the equation

$$\mathrm{HAE}(i,j) = \min\left[\prod_{i=1}^{n}\Big(\mathrm{HA}\,(i,j,k)\Big)m(k)\right]^{k}$$

where

n = the number of life stages being used in the analysis for the species of interest,

k = the life stage,

i = the month,

j = the year,

$\mathrm{HA}(i,j,k)$ = the physical habitat for month i in year j for life stage k, and

$m(k)$ = an equivalent adult multiplier for life stage k.

The ANEQTS program is then used to calculate the annual equivalent adult habitat time series.

The third approach, using *effective* adult habitat, is the preferred approach and is appropriate when there is adequate data and when there is an understanding of year-to-year interactions. The annual effective adult habitat considers events in previous years and uses the annual time series for each life stage. See Waddle (1990b) for information on the logic behind effective adult habitat analysis. There are currently two programs to calculate the annual effective adult habitat time series (EFFHAB and EFFHB2), each of which supports a different life history configuration.

Figure 9.1 diagrams the flow of information through the annual time series programs.

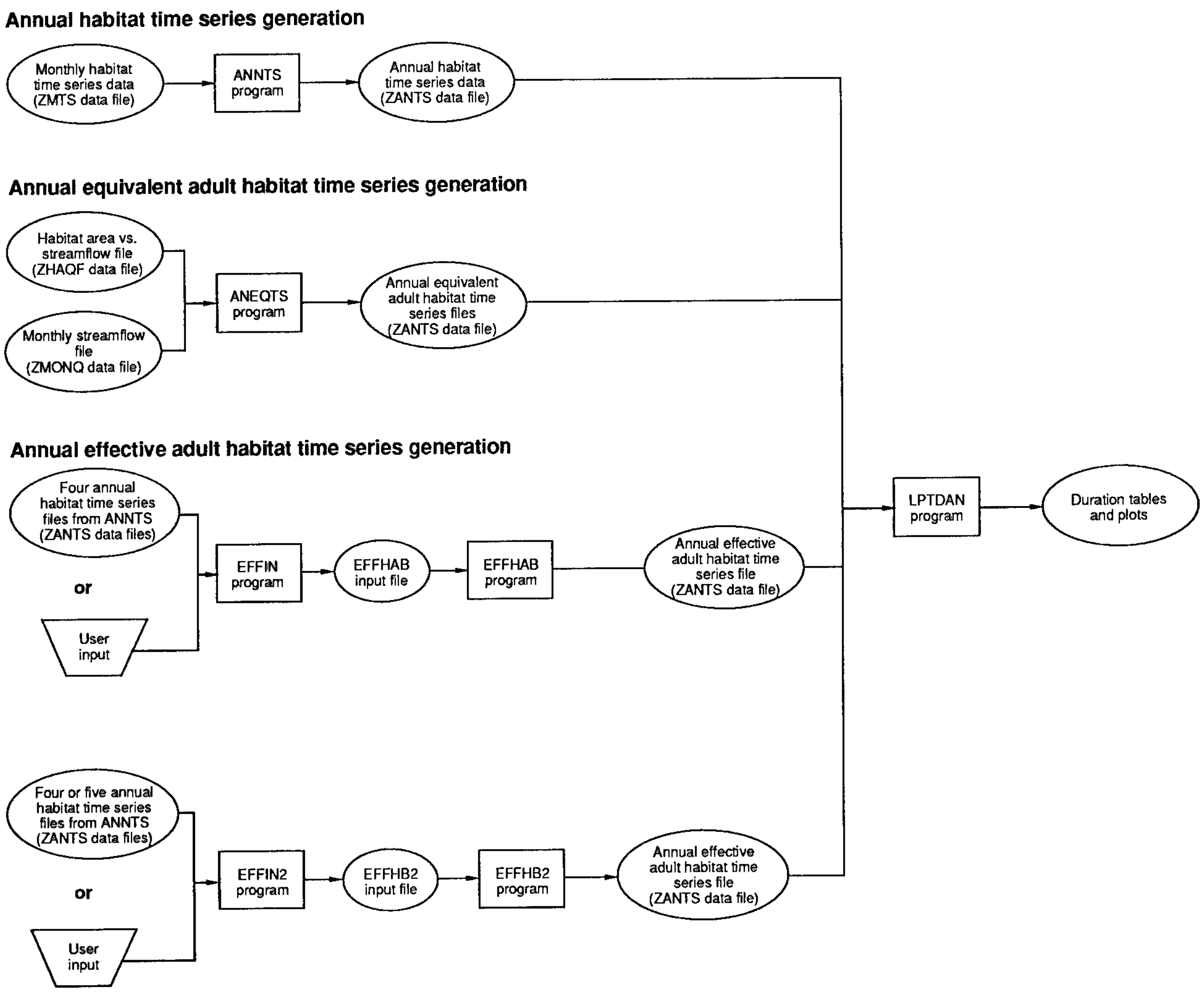


Fig. 9.1. Flow of information through the annual time series programs.

Annual Time Series Generation

Program Name	Batch/Procedure Filename	Function	Program Description
ANNTS	**RANNTS**	Annual time series generation	Creates an annual time series file from a set of monthly time series data. It also produces an output file containing tables and plots of the composite, minimum, and maximum yearly time series values and a table showing duration data for the composite indices. **RANNTS, ZMTS, ZOUT, ZANTS** **ZMTS** = Monthly time series file in USGS or NWDC format; can be a multirecord file. Usually output from HABTD or HABTS (input). **ZOUT** = ANNTS results (output). **ZANTS** = Annual time series file (output).

Annual Equivalent Adult Habitat Time Series Generation

Program Name	Batch/Procedure Filename	Function	Program Description
ANEQTS	**RANEQTS**	Annual equivalent adult time series generation	Computes monthly and annual equivalent adult habitat time series for one species with up to five life stages. **RANEQTS, ZHAQF, ZMONQ, ZOUT, ZMTS, ZANTS** **ZHAQF** = Habitat area-versus-streamflow file for one species with up to five life stages; cannot be a multirecord file (input). **ZMONQ** = Monthly streamflow file in USGS or NWDC format; cannot be a multirecord file (input). **ZOUT** = ANEQTS results, including tables and plots (output). **ZMTS** = Monthly time series file containing equivalent adult habitat values (output). **ZANTS** = Annual time series file containing composite, minimum, and maximum equivalent adult habitat values for each year (output).

Annual Effective Adult Habitat Time Series Generation

Program Name	Batch/Procedure Filename	Function	Program Description
EFFIN	**REFFIN**	Annual effective adult habitat time series generation	Creates an input file for the EFFHAB program from user input or from four annual habitat time series files. **REFFIN, EFHABIN, ZANTS1, ZANTS2, ZANTS3, ZANTS4** **EFHABIN** = EFFHAB input file (output). **ZANTS1** = Annual habitat time series file for adults (input). **ZANTS2** = Annual habitat time series file for spawning (input). **ZANTS3** = Annual habitat time series file for fry (input). **ZANTS4** = Annual habitat time series file for juveniles (input). Note: Input files must contain the same number of years of data and cannot be multirecord files.
EFFHAB	**REFFHAB**	Annual effective adult habitat time series generation	Calculates an effective adult habitat time series for four life stages of a given species. **REFFHAB, EFHABIN, ZANTS, ZOUT** **EFHABIN** = EFFHAB input file created by the EFFIN program (input). **ZANTS** = Annual time series file containing available and effective adult habitats (output). **ZOUT** = List of data and a table of equivalent adult habitats, available equivalent adult habitat used, beginning of the year adults, and the effective habitat time series (output).

Program Name	Batch/Procedure Filename	Function	Program Description
EFFIN2	**REFFIN2**	Annual effective adult habitat time series generation	Creates an input file for the EFFHB2 program from user input or from four or five annual habitat time series files. **REFFIN2, EFHBIN2, ZANTS1, ZANTS2, ZANTS3, ZANTS4, ZANTS5** **EFHBIN2** = EFFHB2 input file (output). **ZANTS1** = Annual habitat time series file for adults (input). **ZANTS2** = Annual habitat time series file for spawning (input). **ZANTS3** = Annual habitat time series file for fry (input). **If five input files are being used:** **ZANTS4** = Annual habitat time series file for second fry age class (input). **ZANTS5** = Annual habitat time series file for juveniles (input). **If four input files are being used:** **ZANTS4** = Annual habitat time series file for juveniles (input). Note: Input files must contain the same number of years of data and cannot be multirecord files.
EFFHB2	**REFFHB2**	Annual effective adult habitat time series generation	Calculates an effective adult habitat time series for four life stages with up to two age classes for fry and up to three age classes for juvenile. **REFFHB2, EFHBIN2, ZANTS, ZOUT** **EFHBIN2** = EFFHB2 input file created by the EFFIN2 program (input). **ZANTS** = Annual time series file containing available and effective adult habitats (output). **ZOUT** = List of data and a table of equivalent adult habitats, available equivalent adult habitat used, beginning of the year adults, and the effective habitat time series (output).

Analysis and Display of Annual Time Series Data

Program Name	Batch/Procedure Filename	Function	Program Description
LPTDAN	**RLPTDAN**	Analyzing and displaying annual time series data	Reads one or two annual time series files and writes an output file containing an annual duration table showing ordered annual data, a summary statistics table containing average, median, index-A, index-B, index-C, 10%, 20%, 80%, and 90% exceedence, and an exceedence plot.

RLPTDAN, ZOUT, ZANTS, ZANTS2

ZOUT = LPTDAN results (output).

ZANTS = Annual time series file (input).

ZANTS2 = Second annual time series file (input).

> Note: Input files do not have to contain the same number of years. Multirecord files may be used.

ANEQTS Program

Introduction

The ANEQTS program computes monthly and annual equivalent adult habitat time series data for one species with up to five life stages. This approach assumes that each year is independent of the preceding year, but that each life stage must be considered. Using *equivalent* adult habitat is useful when the analyst is uncertain about the year-to-year interactions.

The decision equation used is

$$HAE = \min[(HAA*WA), (HAJ*WJ), (HAF*WF), (HAS*WS)]$$

where:

HAE = equivalent adult habitat,

HAA = monthly adult habitat,

HAJ = monthly juvenile habitat,

HAF = monthly fry habitat,

HAS = monthly spawning habitat,

WA = 1.0,

WJ = multiplier to adjust juvenile habitat to represent the adult habitat needed if all the juvenile habitat was utilized,

WF = same as WJ but for fry, and

WS = same as WJ but for spawning.

Only the month a life stage is relevant is used in the equation. For example, spawning may be applicable from June through September and will only be considered for those months.

Running ANEQTS

RANEQTS, ZHAQF, ZMONQ, ZOUT, ZMTS, ZANTS

ZHAQF = Habitat area-versus-streamflow file for one species with up to five life stages; cannot be a multirecord file (input).

ZMONQ = Monthly streamflow file in USGS or NWDC format; cannot be a multirecord file (input).

ZOUT = ANEQTS results, including tables and plots (output).

ZMTS = Monthly time series file containing equivalent adult habitat values (output).

ZANTS = Annual time series file containing composite, minimum, and maximum equivalent adult habitat values for each year (output).

The title lines from the input files will be displayed to help the user verify that the correct files are being used.

```
ENTER  1 FOR LINEAR INTERPOLATION, 2 FOR NONLINEAR.
```

Choose between linear and nonlinear transformation of the streamflow time series into a habitat time series.

If 2 was selected for nonlinear interpolation, the following prompt will appear:

```
ENTER  1 FOR LINEAR TAILS, 2 FOR NONLINEAR.
```

Flow values in the habitat-versus-flow file that are smaller than the lowest or greater than the highest flows in the flow time series file are considered tail flows. Habitat values for these tail flows must be extrapolated. Indicate whether this extrapolation should be linear or nonlinear. Nonlinear extrapolation could give negative or irrational results and you should know how to handle this problem before you select this option.

```
ENTER INDEX FOR FIRST MONTH OF TIME SERIES DATA
(JAN.=1, OCT.=10, ETC.)
```

Enter the number of the first month that appears in the monthly flow time series file. The program will then be able to label the months for output.

```
ENTER FIRST AND LAST VALID MONTHS FOR [—]
(JAN.=1, OCT.=10, ETC.)
```

The ANEQTS program goes through all life stages it encounters in the habitat-versus-flow input file and asks which months are relevant for the life stage. Enter the months, separated by a space, comma, or carriage return.

```
ENTER LIFE STAGE MULTIPLIER FOR [—]:
```

For each life stage, ANEQTS needs to know the multiplier to adjust the habitat to represent the adult habitat needed if all the habitat were utilized.

```
ENTER INDEX FOR FIRST MONTH OF BIOLOGICAL YEAR
(JAN.=1, OCT.=10, ETC.):
```

The number entered in response to this prompt should be the month in which fry hatch (the beginning of the biological year). Incomplete water years will get dropped.

Habitat averages and coefficients of variance will appear on the screen (also written to the output file) for the composite, minimum, and maximum equivalent adult habitat values. The composite (at this time) is the simple average for the relevant months.

```
ENTER   0 FOR NO PLOTS OF ADULT EQUIVALENT HABITAT VALUES
        1 TO PLOT HABITAT VALUES ON THE SCREEN
        2 TO PLOT HABITAT VALUES ON THE ZOUT FILE
        3 TO PLOT HABITAT VALUES ON BOTH.
```

The calculated composite, minimum, and maximum equivalent adult habitat values may be plotted using bar graphs.

Figure 9.2 contains sample output from the ZOUT file from ANEQTS. The ZOUT file contains (1) a copy of the habitat-versus-flow file used as input; (2) a copy of the monthly time series file used as input; (3) the monthly habitat time series data for each life stage of the species being analyzed; (4) the monthly equivalent adult habitat time series for the species being analyzed; (5) the composite, minimum, and maximum equivalent adult habitat time series for the species; and (6) a plot of the composite, minimum, and maximum equivalent adult habitat time series if that option was selected.

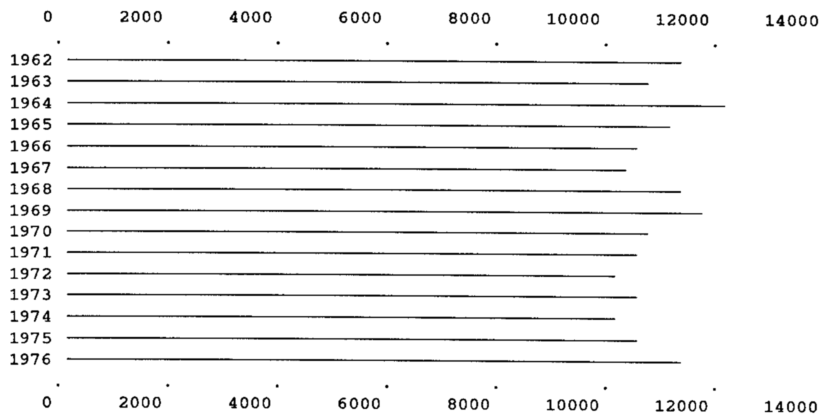
Figure 9.3 is a monthly equivalent adult time series (ZMTS) file from ANEQTS; Fig. 9.4 is a annual equivalent adult time series (ZANTS) file from ANEQTS.

```
DATE - 90/06/06.          SNOQUALMIE RIVER                                    PROGRAM - ANEQTS
TIME - 12.21.09.          NEAR SNOQUALMIE FALLS, WA                             PAGE -    10

         COMPOSITE ADULT EQUIVALENT HABITAT VALUE FOR RAINBOW TROUT
                - JUNE  THRU  MAY

        1962   11184.08     1963   10526.68     1964   11818.50
        1965   10831.51     1966   10339.24     1967   10198.48
        1968   11099.83     1969   11594.71     1970   10544.68
        1971   10281.77     1972    9898.31     1973   10325.97
        1974    9834.98     1975   10256.13     1976   11061.11

        COMPOSITE =    10653.07          C.V. =      0.0555

        MINIMUM ADULT EQUIVALENT HABITAT VALUE FOR RAINBOW TROUT
                - JUNE  THRU  MAY

        1962    6318.80     1963    4045.00     1964    8328.12
        1965    4754.80     1966    3830.67     1967    3974.00
        1968    6442.20     1969    3486.67     1970    3486.67
        1971    5710.80     1972    5528.40     1973    4232.00
        1974    3429.33     1975    5285.20     1976    4981.20

        COMPOSITE =     4922.26          C.V. =      0.2806

        MAXIMUM ADULT EQUIVALENT HABITAT VALUE FOR RAINBOW TROUT
                - JUNE  THRU  MAY

        1962   13595.60     1963   13567.60     1964   13469.60
        1965   13539.60     1966   13458.40     1967   13532.80
        1968   13441.60     1969   13638.80     1970   13559.20
        1971   13556.40     1972   13595.60     1973   13585.80
        1974   13581.60     1975   13609.60     1976   13660.00

        COMPOSITE =    13559.48          C.V. =      0.0047
```

Fig. 9.2. Sample output (ZOUT file) from the ANEQTS program. Only the composite, minimum, and maximum equivalent adult habitat time series data (in tabloid and plotted form) are included.

DATE - 90/06/06. SNOQUALMIE RIVER PROGRAM - ANEQTS
TIME - 12.21.09. NEAR SNOQUALMIE FALLS, WA PAGE - 11

COMPOSITE ADULT EQUIVALENT HABITAT VALUES FOR RAINBOW TROUT
- JUNE THRU MAY



MINIMUM ADULT EQUIVALENT HABITAT VALUES FOR RAINBOW TROUT
- JUNE THRU MAY

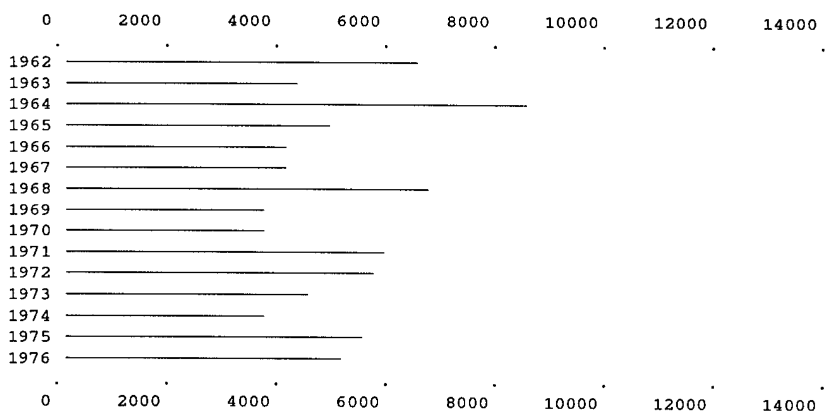


Fig. 9.2. *Continued.*

```
NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH                    1214200000
ADULT EQUIVALENT INDEX - RAINBOW TROUT
12142000     1962 1    13596   13437   12437   10810   10972    7795
12142000     1962 2    12486   13632   13470    9766    8882    6319
12142000     1963 1     9410   12388   12166   12823   12675    9687
12142000     1963 2    13596   13194   12336    7923    4045    4856
12142000     1964 1     9707   12142   13523   12822   11720   12727
12142000     1964 2    13568   11082    8328   12626   13013   12653
12142000     1965 1    11060   13470   12216   10024   11978    9984
12142000     1965 2    13077   13416   13247    7118    4755    7795
12142000     1966 1    10488   13395   12907   13540    8715   13363
12142000     1966 2    12839   11756   13383   12854    3876    3831
12142000     1967 1    12653   13339    8894    8744   13458   12116
12142000     1967 2     8965   12175   11978    7827    4031    3974
12142000     1968 1    12068   13533    8937   10982   10067   12897
12142000     1968 2    13437   12708   12519    7086    7634   13257
12142000     1969 1    13442   12265   13355   12298    6442   12685
12142000     1969 2    13175    8847   12035    7988    3487   12611
12142000     1970 1    12738   11588   13639   12453   13534   12204
12142000     1970 2    13596   13548   13559    5863    3487   10796
12142000     1971 1    11016   13411   13448    9767   11254   12468
12142000     1971 2    13066    8744   10667   12421    5711    6668
12142000     1972 1    11456   11838   13556   12962    8565    8250
12142000     1972 2    12708    8452    8909   12289    5832   11236
12142000     1973 1     5528   12248    9280   13444    7022    8715
12142000     1973 2    10532   13596   13586    5255    4232    4721
12142000     1974 1    12929   13453   11668    8615   13162   12806
12142000     1974 2    13216   10639    8028   12355    8381    3429
12142000     1975 1     4605   13582   12002   10038   13013   12897
12142000     1975 2     8826   10968   11711   13481    9549    5285
12142000     1976 1    13610    9423    7641    8937   10261    7827
12142000     1976 2    13448   11863   13011   13565    9865    5103
12142000     1977 1     4981   12072   13501   13660    9905   10044
12142000     1977 2    13339   13562   13013    4620    4586    8354
```

Fig. 9.3. Sample output (ZMTS file) from the ANEQTS program.

```
NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH                 1214200000
ADULT EQUIVALENT VALUE FOR RAINBOW TROUT
A 12142000   1962          11184.1         6318.8        13595.6
A 12142000   1963          10526.7         4045.0        13567.6
A 12142000   1964          11818.5         8328.1        13469.6
A 12142000   1965          10831.5         4754.8        13539.6
A 12142000   1966          10339.2         3830.7        13458.4
A 12142000   1967          10198.5         3974.0        13532.8
A 12142000   1968          11099.8         6442.2        13441.6
A 12142000   1969          11594.7         3486.7        13638.8
A 12142000   1970          10544.7         3486.7        13559.2
A 12142000   1971          10281.8         5710.8        13556.4
A 12142000   1972           9898.3         5528.4        13595.6
A 12142000   1973          10326.0         4232.0        13585.8
A 12142000   1974           9835.0         3429.3        13581.6
A 12142000   1975          10256.1         5285.2        13609.6
A 12142000   1976          11061.1         4981.2        13660.0
```

Fig. 9.4. Sample output (ZANTS file) from the ANEQTS program. The ZANTS file contains the composite, minimum, and maximum equivalent adult habitat values for each year, in that order.

ANNTS Program

Introduction

The ANNTS program creates an annual time series file from a set of monthly time series data. It also produces an output file containing tables and plots of the composite, minimum, and maximum yearly time series values and a table showing duration data for the composite indices.

The monthly habitat time series files generated by the HABTS and HABTD programs are commonly used as input to ANNTS. The program calculations are listed in the following paragraphs.

Maximum and Minimum Monthly Indices. Considering only those months designated by the user for the annual series, the monthly values provided on the input file are searched for by the ANNTS program. The maximum and minimum values for each year are flagged and written to ZOUT in a tabular and plotted format. In addition, these values are written to an annual time series file (ZANTS).

Composite Index. Again, considering only those months designated by the user for the annual series, each of the available monthly values provided in the input monthly time series (ZMTS) file is multiplied by the number of days in the month. These products are summed, and the sum is divided by the total number of days in the year, or user-designated portion of the year, resulting in a composite index for each year of data. The composite indices are written to ZOUT in a tabular and plotted format. In addition, they are written to the ZANTS file.

Duration for Composite Index. The composite indices calculated (in Composite Index section) are arranged in descending order. The percent exceedence is calculated for each value. A table is then written to ZOUT containing the year, the composite index value, and the percent exceedence.

Note that in the Maximum and Minimum Monthly Indices and Composite Index section, the year is designated as that in which the majority of user-designated months reside. When the number of months included in the annual calculation is split evenly between two years, the later year becomes the designated year.

Running ANNTS

RANNTS, ZMTS, ZOUT, ZANTS

ZMTS = Monthly time series file in USGS or NWDC format; can be a multirecord file (input).

ZOUT = ANNTS results (output).

ZANTS = Annual time series file (output).

The title lines from the first record in the monthly time series will be displayed to help the user verify that the correct file is being used.

```
ENTER   0 FOR NO PLOTS OF ANNUAL TIME SERIES VALUES
        1 TO PLOT ANNUAL VALUES ON THE ZOUT FILE
        2 TO PLOT ANNUAL VALUES ON THE SCREEN
        3 TO PLOT ANNUAL VALUES ON BOTH.
```

The calculated composite, minimum, and maximum annual time series values may be plotted using bar graphs. The composite (at this time) is the simple average for the relevant months.

```
ENTER INDEX FOR FIRST MONTH OF TIME SERIES DATA.
(JAN.=1, OCT.=10, ETC.)
```

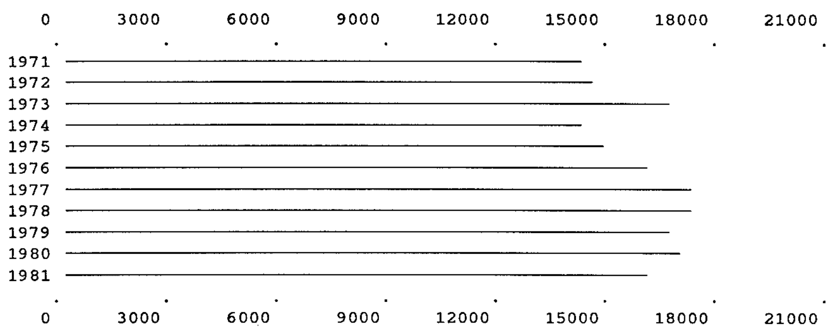
Enter the number of the first month that appears in the monthly time series file. The program will then be able to label the months for output.

```
ENTER FIRST AND LAST VALID MONTHS FOR [—]
(JAN.=1, OCT.=10, ETC.)
```

The ANNTS program goes through all records it encounters (usually life stages) in the monthly time series input file and asks which months are relevant for the record (life stage). Enter the months, separated by a space, comma, or carriage return.

Figure 9.5 contains sample output from the ZOUT file from ANNTS; Fig. 9.6 is an annual time series (ZANTS) file from ANNTS.

```
DATE - 90/06/06.     SNOQUALMIE RIVER                    PROGRAM - ANNTS
TIME - 14.21.38.        FRY      RAINBOW TROUT              PAGE -     2


         COMPOSITE VALUE FOR     FRY      RAINBOW TROUT
                 - JUNE    THRU OCT
        1971   14211.27      1972  14561.75      1973  16685.02
        1974   14378.32      1975  14737.67      1976  16016.41
        1977   17336.25      1978  17334.05      1979  16752.84
        1980   17028.30      1981  15907.09

        MINIMUM VALUE FOR     FRY      RAINBOW TROUT
                 - JUNE    THRU OCT

        1971    9006.00      1972   8325.00      1973  14600.00
        1974    7804.00      1975   9786.00      1976  12494.00
        1977   15855.00      1978  16031.00      1979  15320.00
        1980   15625.00      1981  11700.00

        MAXIMUM VALUE FOR     FRY      RAINBOW TROUT
                 - JUNE    THRU OCT

        1971   17841.00      1972  18655.00      1973  17977.00
        1974   18474.00      1975  17229.00      1976  18238.00
        1977   17876.00      1978  18622.00      1979  17188.00
        1980   18762.00      1981  19105.00


DATE - 90/06/06.        SNOQUALMIE RIVER                 PROGRAM - ANNTS
TIME - 14.21.38.           FRY      RAINBOW TROUT           PAGE -     3


          COMPOSITE INDEX FOR     FRY      RAINBOW TROUT
                  - JUNE    THRU OCT
```




```
          MINIMUM INDEX FOR     FRY      RAINBOW TROUT
                  - JUNE    THRU OCT
```

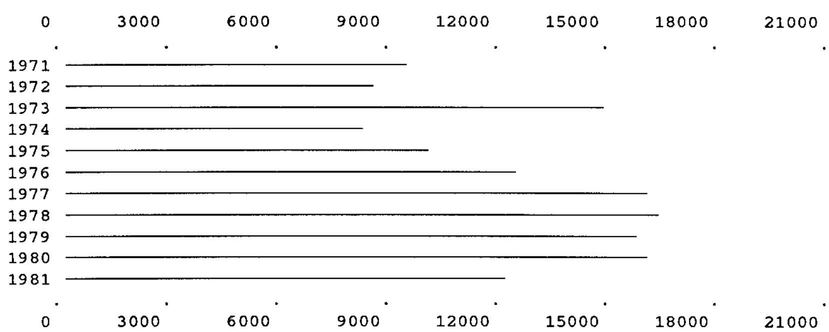
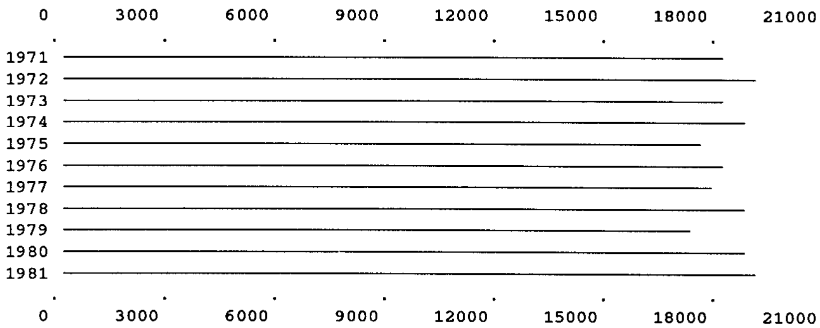


Fig. 9.5. Sample output (ZOUT file) from the ANNTS program. Only the output for Rainbow trout—Fry (first record in the multirecord ZMTS file used as input) has been included.

DATE - 90/06/06. SNOQUALMIE RIVER PROGRAM - ANNTS
TIME - 14.21.38. FRY RAINBOW TROUT PAGE - 4

MAXIMUM INDEX FOR FRY RAINBOW TROUT
- JUNE THRU OCT



DURATION DATA FOR COMPOSITE INDEX

ORDERED DATA FOR 1971 THRU 1981 - FRY RAINBOW TROUT

ORDER NUMBER	YEAR	ELEMENT	EXCEEDENCE
1	1977	17336.25	4.55
2	1978	17334.05	13.64
3	1980	17028.30	22.73
4	1979	16752.84	31.82
5	1973	16685.02	40.91
6	1976	16016.41	50.00
7	1981	15907.09	59.09
8	1975	14737.67	68.18
9	1972	14561.75	77.27
10	1974	14378.32	86.36
11	1971	14211.27	95.45

Fig. 9.5. *Continued.*

```
CLASSA1
SNOQUALMIE RIVER
   FRY      RAINBOW TROUT
A 12142000  1971        14211.3         9006.0        17841.0
A 12142000  1972        14561.7         8325.0        18655.0
A 12142000  1973        16685.0        14600.0        17977.0
A 12142000  1974        14378.3         7804.0        18474.0
A 12142000  1975        14737.7         9786.0        17229.0
A 12142000  1976        16016.4        12494.0        18238.0
A 12142000  1977        17336.2        15855.0        17876.0
A 12142000  1978        17334.1        16031.0        18622.0
A 12142000  1979        16752.8        15320.0        17188.0
A 12142000  1980        17028.3        15625.0        18762.0
A 12142000  1981        15907.1        11700.0        19105.0
#EOR
CLASSA2
SNOQUALMIE RIVER
  JUVENILE RAINBOW TROUT
A 12142000  1971        10502.0         8165.0        13246.0
A 12142000  1972         9781.7         7892.0        13459.0
A 12142000  1973         9421.4         6166.0        14240.0
A 12142000  1974         9306.1         6025.0        13166.0
A 12142000  1975        10600.1         7595.0        12469.0
A 12142000  1976        10850.5         7163.0        13878.0
A 12142000  1977         9571.4         6922.0        12536.0
A 12142000  1978        10327.8         7193.0        14229.0
A 12142000  1979         9050.7         5824.0        14295.0
A 12142000  1980         9793.3         6585.0        14608.0
A 12142000  1981         9707.1         5650.0        13070.0
#EOR
CLASSA3
SNOQUALMIE RIVER
   ADULT    RAINBOW TROUT
A 12142000  1971         8645.2         5691.0        12098.0
A 12142000  1972         7855.2         5479.0        11600.0
A 12142000  1973         7133.3         4244.0        11776.0
A 12142000  1974         7580.0         4108.0        12147.0
A 12142000  1975         8561.0         5384.0        11463.0
A 12142000  1976         8490.2         5067.0        11969.0
A 12142000  1977         7094.0         4701.0         9908.0
A 12142000  1978         7690.3         4899.0        11148.0
A 12142000  1979         6785.6         3988.0        11583.0
A 12142000  1980         7271.8         4472.0        11736.0
A 12142000  1981         7495.5         3836.0        11392.0
#EOR
```

Fig. 9.6. Sample output (ZANTS file) from the ANNTS program.

EFFHAB Program

Introduction

The EFFHAB program calculates an effective adult habitat time series for four life stages of a given species by comparing habitat required with habitat available. The program first converts all available habitat data for spawning, fry, and juveniles, from the input file created by the EFFIN program, into adult equivalent habitat area using the equivalent adult habitat multipliers (habitat ratios) supplied in the input file.

The EFFIN and EFFHAB programs make the following assumptions regarding the data:

1. The year begins with the month the fish are hatched. This is very important. Be sure that the available habitat data have been calculated as such.
2. In the first year of a fish's life, or portion of that year, the fish is in the fry stage. It lives the second year of its life as a juvenile. Beginning with the third year of its life it is considered to be an adult.
3. Mortality is considered only from year to year in adults. Spawning, fry, and juvenile mortality should be taken into consideration in the equivalent adult habitat multipliers.
4. All life stages are initially at carrying capacity; that is, for the first year, all the available habitat is utilized. Thus, the first few years of calculations will not be as accurate as later years.

EFFHAB then begins calculating the effective adult habitat time series. To calculate the effective adult habitat for year I (with I ≥ 3), first determine the adult survivors through year I – 1 by multiplying the effective adult habitat for year I – 1 by the adult survival factor. Second, determine the recruits to adults at the beginning of year I by comparing the following four values:

1. The effective adult habitat for year I – 3 (which determines the number of adults available for spawning);
2. The available habitat for spawners in year I – 3;
3. The available habitat for fry in year I – 2; and
4. The available habitat for juveniles in year I – 1.

The smallest of the above four values comprises the recruits to adults at the end of year I – 1 (beginning of year I). The sum of the recruits to adults at the beginning of year I plus the adult survivors through year I – 1 (at the beginning of year I) becomes the required adult habitat for year I. The available adult habitat for year I is then compared with the required adult habitat for year I, and the lesser of the two values is the effective habitat for year I.

Running EFFHAB

REFFHAB, EFHABIN, ZANTS, ZOUT

EFHABIN = EFFHAB input file created by the EFFIN program (input).

ZANTS = Annual time series file containing available and effective adult habitats (output).

ZOUT = List of data and a table of equivalent adult habitats, available equivalent adult habitat used, beginning of the year adults, and the effective habitat time series (output).

Figures 9.7 and 9.8 contain sample output from the EFFHAB program.

```
SAMPLE INPUT FILE TO THE EFFHAB PROGRAM CREATED BY THE EFFIN PROGRAM
EFFECTIVE HABITAT FOR GUNNISON RIVER BROWN TROUT - ONE YEAR JUVENILE
                        AVAILABLE      EFFECTIVE
C GUNNISON  1980        12049.8        12049.8
C GUNNISON  1981        20884.4         4435.6
C GUNNISON  1982        23498.0         2506.1
```

Fig. 9.7. Sample output (ZANTS file) from the EFFHAB program.

```
SAMPLE INPUT FILE TO THE EFFHAB PROGRAM CREATED BY THE EFFIN PROGRAM
EFFECTIVE HABITAT FOR GUNNISON RIVER BROWN TROUT - ONE YEAR JUVENILE

ADULT EQUIVALENT HABITAT FACTORS-
          ADULT SPAWNING      10.000
          ADULT FRY            8.000
          ADULT JUVENILE       4.000

          SURVIVAL FACTOR       0.250

              ADULT        SPAWNING          FRY         JUVENILE
1980        12049.8         4066.0         245.0           355.8
1981        20884.4         3144.0         345.0           349.3
1982        23498.0         4190.0         509.0           400.2
```

		EQUIVALENT ADULT			END OF YEAR			EFFECTIVE
YEAR	ADULT	SPAWNING	FRY	JUVENILE	NEW ADULT	SURVIVORS	TOTAL	HABITAT
1980	12049.80	40660.00	1960.00	1423.20	1423.20	3012.45	4435.65	12049.80
1981	20884.40	31440.00	2760.00	1397.20	1397.20	1108.91	2506.11	4435.65
1982	23498.00	41900.00	4072.00	1600.80	1600.80	626.53	2227.33	2506.11

Fig. 9.8. Sample output (ZOUT file) from the EFFHAB program.

EFFHB2 Program

Introduction

The EFFHB2 program calculates an effective adult habitat time series for four life stages with up to two age classes for fry and up to three age classes for juveniles. EFFHB2 calculates an effective adult habitat time series for a given species, assuming that the species' life cycle consists of

- a fry life stage for all or part of the first year, which may be divided into two age classes, both existing during the single year;
- from one to three juvenile life stages each existing for one year or portion of a year; thus, the first juvenile life stage begins at one year old, the second juvenile life stage (which is optional) begins at two years old, and the third juvenile life stage (also optional) begins at three years old;
- an adult life stage that begins at either the second, third, or fourth birthday, depending on the number of juvenile life stages in existence; and
- a spawning life stage that occurs for a portion of each adult year.

The EFFIN2 program creates an input file for the EFFHB2 program. The EFFIN2 and EFFHB2 programs make the following assumptions regarding the data:

1. The year begins with the month the fish are hatched. This is very important. Be sure that the available habitat data have been calculated as such.
2. In the first year of a fish's life, or portion of that year, the fish is in the fry stage. It lives the second year of its life as a juvenile. Beginning with the third, fourth, or fifth year of its life, it is considered an adult.
3. Mortality is considered separately from year to year *only* in adults. Spawning, fry, and juvenile mortality should be taken into consideration in the equivalent adult habitat multipliers.
4. All life stages are initially at carrying capacity. That is, for the first year, all the available habitat is utilized. Thus, the first few years of calculations will not be as accurate as later years.

An annual effective adult habitat time series is calculated by comparing habitat area available with habitat area required by each life stage or age class. Four or five annual available habitat time series must therefore be provided: one for adults; one for spawning; one for each fry age class; and one for juveniles. The EFFHB2 program is designed such that the juvenile life stages are competitive—that is, the single juvenile available habitat time series is divided among the one to three juvenile life stages. Either the user designates the percentage of habitat to be allocated to each juvenile life stage or the option is available to permit the oldest juvenile life stage all that they require, in which case the middle juvenile life stage would take what they require from the remainder, and the rest would go to the youngest juvenile life stage. This option is also available when only two juvenile life stages exist. For the remainder of this document, this option will be called the "pecking order option."

The EFFHB2 program apportions the juvenile habitat when more than one juvenile life stage is being used. This is done by straight percentages if the user has so designated. When the pecking order option has been selected, all the juvenile habitat is allocated to the oldest, with the others getting none for the present. The program then converts the four or five available habitat time series, read from the input file created by the EFFIN2 program, into equivalent adult habitat time series by using the equivalent adult habitat multipliers.

The EFFHB2 program then begins calculating the effective adult habitat time series. It should be noted that all life stages are assumed to be at carrying capacity in the beginning—that is, for the first year of calculations, it is assumed that all available habitat is used. The following paragraph gives a description of how this assumption is made for juveniles when the user designates the pecking order option described previously.

A starting point is established for the juveniles when the pecking order option is chosen by calculating the juvenile habitat for each juvenile life stage that would have been required to use all the adult habitat available in the first year. These required quantities of habitat (one for each juvenile life stage) are summed, and the sum is compared with the available juvenile habitat for the first year. When the amount of available juvenile habitat is less than required, the oldest life stage (or stages) is given priority and the youngest suffers the shortage. When the amount of available juvenile habitat is greater than required, the extra is allocated according to the percent of total each life stage requires.

In calculating the effective adult habitat time series, the EFFHB2 program progresses year by year, advancing each life stage to the next and comparing required equivalent adult habitat with available adult equivalent habitat. From year two onward, the calculations progress as follows:

1. The amount of adult habitat required at the beginning of the year (beginning-of-year adults) is calculated by multiplying the effective adult habitat from the previous year by the survival factor and adding to that product the amount of adult equivalent habitat used by the oldest juvenile life stage in the previous year.

2. The effective adult habitat (amount of habitat used by adults in the present year) is designated as the smaller of either the available adult habitat for the present year or the beginning-of-year adults calculated in step 1.
3. The required spawning habitat is set equal to the effective adult habitat for the present year calculated in step 2. It is then compared with the available equivalent adult spawning habitat for the present year and the lesser of the two values becomes the used spawning equivalent adult habitat for the present year. Remember that the fish spawn at the end of the year and are hatched in the next year—that is, the new year begins on the fish's birthday for the purpose of the EFFHB2 program.
4. The required fry habitat (for the younger fry age class) is set equal to the used spawning equivalent adult habitat for the previous year, which is then compared with the available equivalent adult fry (younger age class) habitat for the present year and the smaller of the two values becomes the used fry (younger age class) equivalent adult habitat for the present year.
5. When a second fry age class is being considered, the required fry habitat (for the older fry age class) is set equal to the used fry equivalent adult habitat for the present year (calculated in step 4). (Remember that for the purpose of the EFFHB2 program, fry go through both age classes in the same year.) This number is then compared with the available equivalent adult fry (older age class) habitat for the present year and the lesser of the two values becomes the used fry (older age class) equivalent adult habitat for the present year.
6. When the pecking order option is selected and three juvenile life stages are being used, skip step 6. The required habitat for the youngest juvenile life stage, called juvenile 1, is set equal to the used fry (oldest age class) equivalent adult habitat for the previous year. It is then compared with the available equivalent adult juvenile 1 habitat for the present year and the lesser of the two values becomes the used juvenile 1 equivalent adult habitat for the present year. If a second juvenile life stage is being considered, the required habitat for this life stage, called juvenile 2, is set equal to the used juvenile 1 equivalent adult habitat for the previous year. It is then compared with the available equivalent adult juvenile 2 habitat for the present year, and the lesser of the two values becomes the used juvenile 2 equivalent adult habitat for the present year. If a third juvenile life stage is being considered, the required habitat for this life stage, called juvenile 3, is set equal to the used juvenile 2 equivalent adult habitat for the previous year. It is then compared with the available equivalent adult juvenile 3 habitat for the present year and the lesser of the two values becomes the used juvenile 3 equivalent adult habitat for the present year. When two juvenile life stages are being used, if one shows a shortage of available habitat and the other does not use all that it has available, the extra is given to the one in need and the appropriate used equivalent adult habitat is recalculated. When three juvenile life stages are being used and one of them shows a shortage of available habitat, all the extra is given to the one in need and its used equivalent adult habitat is recalculated. When three juvenile life stages are being used and two of them show a shortage of available habitat, the extra from the third is divided between the two in proportion to the initial percentages the user allocated, and the two used equivalent adult habitat values are recalculated. If only one is still in need, any extra from the other is donated, and the one used equivalent adult habitat value is calculated a third time.
7. This step is valid only when the pecking order option is selected using three juvenile life stages. The required juvenile 3 (oldest) habitat is set equal to the used juvenile 2 (middle) habitat for the previous year. It is then compared with the available equivalent adult juvenile 3 habitat for the present year and the lesser of the two values becomes the used juvenile 3 equivalent adult habitat for the present year. (Remember that in this instance, the available juvenile 3 habitat consists of all the available juvenile habitat.) When there is no extra available juvenile 3 habitat (used juvenile 3 = available juvenile 3), used juvenile 2 and used juvenile 1 equivalent adult habitat for the present year are set equal to zero and step 7 is complete. When there is extra available juvenile 3 habitat (used juvenile 3 = required juvenile 3), the extra is converted to available equivalent adult juvenile 2 habitat for the present year. The required juvenile 2 habitat is set equal to the used juvenile 1 habitat for the previous year. It is then compared with the available equivalent adult juvenile 2 habitat for the present year, and the lesser of the two values becomes the used juvenile 2 equivalent adult habitat for the present year. When there is no extra available juvenile 2 habitat (used juvenile 2 = available juvenile 2), used juvenile 1 equivalent adult habitat for the present year is set equal to zero and step 7 is complete. When there is extra available juvenile 2 habitat (used juvenile 2 = required juvenile 2), the extra is converted to available equivalent adult juvenile 1 habitat for the present year. The required juvenile 1 habitat is set equal to the used fry (oldest age class) habitat for the previous year. It is then compared with the available equivalent adult juvenile 1 habitat for the present year, and the

lesser of the two values becomes the used juvenile 1 equivalent adult habitat for the present year.

Running EFFHB2

REFFHB2, EFHBIN2, ZANTS, ZOUT

EFHBIN2 = EFFHB2 input file created by the EFFIN2 program (input).

ZANTS = Annual time series file containing available and effective adult habitats (output).

ZOUT = List of data and a table of equivalent adult habitats, available equivalent adult habitat used, beginning of the year adults, and the effective habitat time series (output).

Figures 9.9 and 9.10 contain sample output from the EFFHB2 program.

```
SAMPLE INPUT FILE TO THE EFFHB2 PROGRAM CREATED BY THE EFFIN2 PROGRAM
EFFECTIVE HABITAT FOR GUNNISON RIVER BROWN TROUT - ONE-YEAR JUVENILE
               AVAILABLE      EFFECTIVE
C GUNNISON  1964       13049.0        13049.0
C GUNNISON  1965       12719.0        12719.0
```

Fig. 9.9. Sample output (ZANTS file) from the EFFHB2 program.

```
SAMPLE INPUT FILE TO THE EFFHB2 PROGRAM CREATED BY THE EFFIN2 PROGRAM
EFFECTIVE HABITAT FOR GUNNISON RIVER BROWN TROUT - ONE-YEAR JUVENILE

ADULT EQUIVALENT HABITAT FACTORS-
          ADULT SPAWNING        10.000
          ADULT SWIMUP           8.000
          ADULT FINGERLING       4.000
          ADULT JUVENILE         2.000

          SURVIVAL FACTOR        0.250

           HABITAT AVAILABLE TO EACH LIFESTAGE

               ADULT    SPAWNING  SWIMUP      FINGERLING   JUVENILE
      1964    13049.0     4063.0        32.3        528.0     12715.0
      1965    12719.0     2521.0         4.8        173.0     13551.0

                     EQUIVALENT ADULT HABITAT AVAILABLE                BEGINNING OF    EFFECTIVE
YEAR     ADULT     SPAWNING  SWIMUP      FINGERLING  JUVENILE             YEAR ADULTS      HABITAT

1964  13049.00    40630.00       258.40     2112.00    25430.00        -99999.99       13049.00

1965  12719.00    25210.00        38.40      692.00    27102.00         28692.25       12719.00

                     EQUIVALENT ADULT HABITAT USED                     BEGINNING OF    EFFECTIVE
YEAR     ADULT     SPAWNING  SWIMUP      FINGERLING  JUVENILE             YEAR ADULTS      HABITAT

1964  13049.00    13049.00       258.40     2112.00    25430.00        -99999.99       13049.00

1965  12719.00    12719.00        38.40       38.40     2112.00         28692.25       12719.00
```

Note: In the last table, the adult habitat used and the effective habitat are the same. They will always be the same since effective habitat is defined as usable adult habitat.

Fig. 9.10. Sample output (ZOUT file) from the EFFHB2 program.

EFFIN Program

Introduction

The EFFIN program creates an input file for the EFFHAB program that calculates an effective adult habitat time series for four life stages of a given species. Input to EFFIN is either entered directly from the keyboard or read from four annual habitat time series (ZANTS) files. The ZANTS files were created by the ANNTS program using a monthly time series file (ZMTS) generated by the HABTD or HABTS programs as input.

If ZANTS files are being used as input to the EFFIN program, the first input file should contain values for adults; the second, values for spawning, the third for fry, and the fourth for juvenile. All four input files must contain the same number of years of data and cannot be multi-record files.

The EFFIN and EFFHAB programs make the following assumptions regarding the data:

1. The year begins with the month the fish are hatched. This is very important. Be sure that the available habitat data have been calculated as such.
2. In the first year of a fish's life, or portion of that year, the fish is in the fry stage. It lives the second year of its life as a juvenile. Beginning with the third year of its life it is considered to be an adult.
3. Mortality is considered only from year to year in adults. Spawning, fry, and juvenile mortality should be taken into consideration in the adult equivalent habitat multipliers.
4. All life stages are initially at carrying capacity—that is, for the first year, all the available habitat is utilized. Thus, the first few years of calculations will not be as accurate as later years.

Figure 9.11 contains a sample input file to the EFFHAB program created by EFFIN.

Running EFFIN

REFFIN, EFHABIN, ZANTS1, ZANTS2, ZANTS3, ZANTS4

EFHABIN = EFFHAB input file (output).

ZANTS1 = Annual habitat time series files for adults (input).

ZANTS2 = Annual habitat time series files for spawning (input).

ZANTS3 = Annual habitat time series files for fry (input).

ZANTS4 = Annual habitat time series files for juveniles (input).

Input files must contain the same number of years of data and cannot be multirecord files.

```
ENTER   0 TO USE ANNUAL TIME SERIES FILES AS INPUT
        1 TO ENTER ALL DATA FROM KEYBOARD
:
```

Remember, if annual time series files (ZANTS) files are being used as input, they must contain the same number of years and have been entered in the following order when EFFIN was run: adults, spawning, fry, juveniles.

```
ENTER TWO LINE TITLE:
```

Enter a 2-line title for the output file using a maximum of 80 characters per line.

```
ENTER THE ADULT SURVIVAL FACTOR:
```

The adult survival factor must be between 0.0 and 1.0 and remains constant throughout the program run.

```
ENTER THE ADULT EQUIVALENT HABITAT MULTIPLIERS FOR
SPAWNING, FRY, AND JUVENILE, IN THAT ORDER:
```

```
SAMPLE INPUT FILE TO THE EFFHAB PROGRAM CREATED BY THE EFFIN PROGRAM
EFFECTIVE HABITAT FOR GUNNISON RIVER BROWN TROUT - ONE YEAR JUVENILE
 .25    10.00     8.00     4.00
                              ADULT        SPAWNING           FRY       JUVENILE
E GUNNISON  1980            12049.8         4066.0          245.0          355.8
E GUNNISON  1981            20884.4         3144.0          345.0          349.3
E GUNNISON  1982            23498.0         4190.0          509.0          400.2
```

Fig. 9.11. Sample input file to the EFFHAB program created by EFFIN.

Enter the multipliers separated by a comma, space, or carriage return. These multipliers remain constant throughout the program run.

```
ENTER STATION ID (8 CHAR):
```

If annual time series files were used as input, the following prompts will appear in addition to those explained above:

```
DATASET IS [——]
```

The following prompts will be repeated *four* times—once for each input ZANTS file. The blank will show the two title lines from the input file being considered.

```
ENTER   0 FOR COMPOSITE
        1 FOR MINIMUM
  OR    2 FOR MAXIMUM AS RELEVANT TIME SERIES
```

This prompt refers to the three columns of numbers on the annual time series file. The first column is the composite annual habitat value (average of the maximum and minimum values for the relevant months). The second and third values are the minimum and maximum annual habitat values, respectively. You must choose the index appropriate for the species–life stage.

For example, a maximum value for spawning is used under the assumption that the spawn will occur anytime within a certain (temperature–flow) window. In contrast, a minimum value may be more appropriate for fry, which are more vulnerable to catastrophic events. For more resilient adults, an average may be the most appropriate. In any case, you must choose a biologically reasonable response.

```
ENTER   1 TO ADD A YEAR TO THE DATA
        2 TO SUBTRACT A YEAR FROM THE DATA
        0 TO LEAVE THE YEARS UNCHANGED
```

This prompt allows you to ensure that the annual index applies to the correct biological year (biological year is defined as beginning with the month of the hatch or swimup). You are responsible for defining how you wish to numerically refer to a biological year and making sure that annual index values are synchronized to each biological year for each interdependent life stage. (This is a challenge—an example follows.)

Most monthly habitat time series analyses are performed in a water year format—that is, month 1 is October, month 2 is November, and so forth. October of water year 1960 is really in calendar year 1959. To further complicate matters, the ANNTS program may have changed the year designation based on its algorithm of choosing the year from the greatest number of months considered in the annual index calculation.

Hatch of a *theoretical* fall-spawning species is in March and April. We further assume that the fry life stage may be from March through November, juvenile from December through February, and adults are present all year. The biological year, by definition, will be from March to February. In this case, the fry habitat value from (calendar year [and water year]) 1960 matches the habitat value that should be used to characterize biological year 1960. However, the juvenile habitat value from (calendar year [and water year]) 1960 really applies to biological year 1959. This is because the December through February habitat value following the hatch is in the next water year. (In addition, ANNTS would have put the habitat values into 1960 because the majority of months, January and February, occur in calendar year 1960.) Thus, you would need to subtract 1 year from the annual designation for juveniles. Adults, present year round in our example, will not need to be changed. Figure 9.12 diagrams this concept.

All this can be confusing. We recommend that the output from both ANNTS and EFFIN be scrutinized to make sure that the biological year is properly characterized and all life stages are synchronized before running the EFFHAB

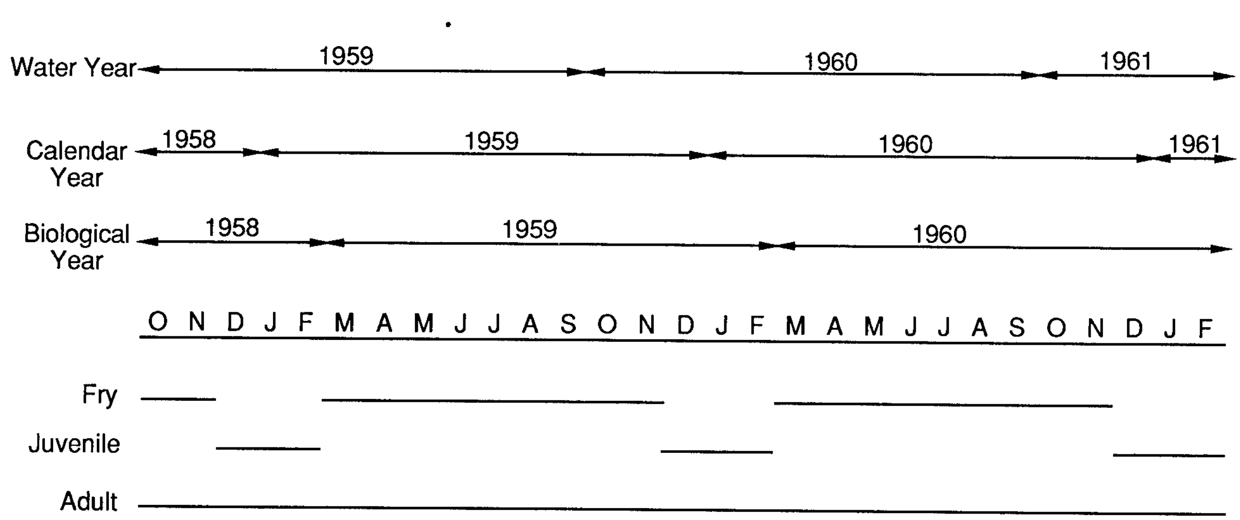


Fig. 9.12. Determination of the correct year number in the EFFIN and EFFIN2 programs.

program. You may need to delete mismatched biological years from certain life stages when you have finished, using a text editor. Totally illogical results are assured if care is not taken.

```
COMPOSITE FILE WITH [—] YEARS WRITTEN.
```

The blank will contain the number of years of data written to the output file. The output file should now contain the data in a format that can be read by the EFFHAB program.

If all data is being entered from the keyboard, the following prompts will appear in addition to those explained previously:

```
ENTER FIRST YEAR OF DATA:
```

Enter the year number for the first year of data: example, 1980.

```
ENTER ANNUAL HABITAT DATA:

[Enter 4 values for each year in this format:
                                    ##########.#.
Separate each value with a space and follow the fourth value
with a carriage return. When all years of data
have been entered, type Q to quit.]
Year  Adult   Spawning   Fry   Juvenile
xxxx
```

[xxxx] is the first year number entered in the prompt Enter first year of data:

EFFIN2 Program

Introduction

The EFFIN2 program creates an input file for the EFFHB2 program that calculates an effective adult habitat time series for four life stages with up to two age classes for fry and up to three age classes for juveniles. EFFHB2 assumes that the species' life cycle consists of

1. a fry life stage for all or part of the first year, which may be divided into two age classes, both existing during the single year;
2. from one to three juvenile life stages, each existing for one year or portion of a year; thus, the first juvenile life stage begins at one year old, the second juvenile life stage (optional) begins at two years old, and the third juvenile life stage (optional) begins at three years old;
3. an adult life stage begins at either the second, third, or fourth birthday, depending on the number of juvenile life stages in existence; and
4. a spawning life stage that occurs for a portion of each adult year.

Input to EFFIN2 is either entered directly from the keyboard or read from four or five annual habitat time series files (ZANTS). The ZANTS files are created by the ANNTS program using a monthly time series file (ZMTS) generated by the HABTD or HABTS programs as input.

If ZANTS files are being used as input to the EFFIN2 program, the first input file should contain values for adults, the second, values for spawning, and the third, values for fry. If five ZANTS files are used as input, the fourth file should contain values for the second fry age class and the fifth should contain juvenile values. If only four ZANTS files are used as input, then the fourth file should contain values for juveniles. All four or five ZANTS files must contain the same number of years of data and cannot be multirecord files.

The EFFIN2 and EFFHB2 programs make the follow assumptions regarding the data:

1. The year begins with the month the fish are hatched. This is very important. Be sure that the available habitat data have been calculated as such.
2. In the first year of a fish's life, or portion of that year, the fish is in the fry stage. It lives the second year of its life as a juvenile. Beginning with the third, fourth, or fifth year of its life, it is considered an adult.
3. Mortality is considered separately from year to year only in adults. Spawning, fry, and juvenile mortality should be taken into consideration in the adult equivalent habitat multipliers.
4. All life stages are initially at carrying capacity—that is, for the first year, all the available habitat is used. Thus, the first few years of calculations will not be as accurate as later years.

Figure 9.13 contains a sample input file to the EFFHB2 program created by EFFIN2.

Running EFFIN2

REFFIN2, EFHBIN2, ZANTS1, ZANTS2, ZANTS3, ZANTS4, ZANTS5

EFHBIN2 = EFFHB2 input file (output).

ZANTS1 = Annual habitat time series file for adults (input).

ZANTS2 = Annual habitat time series file for spawning (input).

ZANTS3 = Annual habitat time series file for fry (input).

If 5 input files are being used:

ZANTS4 = Annual habitat time series file for second fry age class (input).

ZANTS5 = Annual habitat time series file for juveniles (input).

```
SAMPLE INPUT FILE TO THE EFFHAB2 PROGRAM CREATED BY THE EFFIN2 PROGRAM
EFFECTIVE HABITAT FOR GUNNISON RIVER BROWN TROUT - ONE-YEAR JUVENILE
.25   10.00    8.00    4.00    2.00    0.00    0.00
 2
SWIMUP
FINGERLING
 1
JUVENILE
E GUNNISON  1964      13049.0       4063.0         32.3        528.0      12715.0
E GUNNISON  1965      12719.0       2521.0          4.8        173.0      13551.0
```

Fig. 9.13. Sample input file to the EFFHB2 program created by EFFIN2.

If 4 input files are being used:

ZANTS4 = Annual habitat time series file for juveniles (input).

> Input files must contain the same number of years of data and cannot be multirecord files.

```
ENTER   0 TO USE ANNUAL TIME SERIES FILES FOR INPUT
        1 TO ENTER ALL DATA FROM KEYBOARD
```

Remember, if annual times series files (ZANTS) are being used as input, they must contain the same number of years and have been entered in the order described (in running EFFIN2 section) when running EFFIN2.

```
ENTER TWO LINE TITLE:
```

Enter 2-line title for the output file using a maximum of 80 characters per line.

```
THE FRY LIFE STAGE MAY BE DIVIDED INTO 2 AGE CLASSES
EXISTING IN THE SAME YEAR. EACH MUST HAVE ITS OWN
AVAILABLE HABITAT TIME SERIES. HOW MANY FRY AGE CLASSES
WILL BE USED (1 OR 2)?
```

If 1 is entered, the fry life stage will be named FRY.

If 2 is entered, the following prompts will appear:

```
ENTER THE NAME OF THE YOUNGER AGE CLASS (10 CHARS MAX):
```

Enter a name (10 characters or less) for the younger fry age class.

```
ENTER THE NAME OF THE OLDER FRY AGE CLASS (10 CHARS MAX):
```

Enter a name (10 characters or less) for the older fry age class.

```
FROM 1 TO 3 JUVENILE LIFE STAGES MAY BE CONSIDERED,
EACH EXISTING ALL YEAR ( JUVENILE1 = 1 YEAR OLDS,
JUVENILE2 = 2 YEAR OLDS, JUVENILE3 = 3 YEAR OLDS).
ONLY 1 JUVENILE AVAILABLE HABITAT TIME SERIES CAN BE
PROVIDED, AND THAT HABITAT WILL BE SPLIT AMONG THE
LIFE STAGES AS THE USER DESIGNATES. HOW MANY JUVENILE
LIFE STAGES WILL BE USED (1, 2, OR 3)?
```

If 1 is entered, the single juvenile life stage will be named JUVENILE.

If 2 is entered, the following prompts will appear:

```
ENTER NAME OF THE YOUNGEST JUVENILE LIFE STAGE (10 CHARS MAX):
```

Enter name (10 characters or less) for the youngest juvenile life stage.

```
ENTER NAME OF THE SECOND JUVENILE LIFE STAGE (10 CHARS MAX):
```

Enter name (10 characters or less) for the older life stage.

> The responses to the following two prompts must add up to 100.0.

```
THE AVAILABLE JUVENILE HABITAT MUST BE DIVIDED BETWEEN THE 2
JUVENILE LIFE STAGES. ENTER THE PERCENT OF JUVENILE HABITAT
THAT SHOULD BE ALLOTTED TO THE OLDER JUVENILE LIFE STAGE
-[____]. TO ALLOT THE OLDER ALL THEY WANT AND THE YOUNGER WHAT
IS LEFT OVER, ENTER 100.0.
```

The blank will contain the name entered above. Enter the percentage, from 0.0 to 100.0.

```
ENTER THE PERCENT TO BE ALLOTTED TO THE YOUNGER JUVENILE LIFE
STAGE-[____]. TO ALLOT THEM WHAT IS LEFT OVER FROM THE OLDER
LIFE STAGE, ENTER 0.0.
```

The blank will contain the name entered here. Enter the percentage, from 0.0 to 100.0. Remember, the sum of the responses to these two prompts must equal 100.0.

If 3 was entered for the number of juvenile life stages, the following prompts will appear:

```
ENTER NAME OF THE YOUNGEST JUVENILE LIFE STAGE (10 CHARS MAX):
```

Enter a name (10 characters or less) for the youngest juvenile life stage.

```
ENTER NAME OF THE SECOND JUVENILE LIFE STAGE (10 CHARS MAX):
```

Enter a name (10 characters or less) for the middle life stage.

```
ENTER NAME OF THE OLDEST JUVENILE LIFE STAGE (10 CHARS MAX):
```

Enter a name (10 characters or less) for the oldest life stage.

In addition to these prompts, the following prompts will also be asked if "3" was entered to indicate that there are three juvenile life stages.

> The responses to the following three prompts must add up to 100.0.

```
THE AVAILABLE JUVENILE HABITAT MUST BE DIVIDED AMONG THE 3
JUVENILE LIFE STAGES. FOR THE SPECIAL CASE IN WHICH THE OLDEST
TAKE ALL THEY NEED, THE MIDDLE TAKE WHAT THEY NEED FROM WHAT
IS LEFT, AND THE YOUNGEST GET WHAT IS LEFT OVER FROM THE 2
OLDER STAGES, ENTER 100.0 FOR THE OLDEST LIFE STAGE AND
0.0 FOR THE MIDDLE AND YOUNGEST LIFE STAGES. ENTER THE
PERCENT OF JUVENILE HABITAT THAT SHOULD BE ALLOTTED TO THE
OLDEST JUVENILE LIFE STAGE-[-].
```

The blank will contain the name entered previously. Enter the percentage, from 0.0 to 100.0.

```
ENTER THE PERCENTAGE TO BE ALLOTTED TO THE MIDDLE
JUVENILE LIFE STAGE-[—].
```

The blank will contain the name entered previously. Enter the percentage, from 0.0 to 100.0.

```
ENTER THE PERCENTAGE TO BE ALLOTTED TO THE YOUNGEST
JUVENILE LIFE STAGE-[—].
```

The blank will contain the name entered previously. Enter the percentage, from 0.0 to 100.0. Remember, the sum of the responses to these three prompts must equal 100.0.

```
ENTER THE ADULT SURVIVAL FACTOR:
```

The adult survival factor must be between 0.0 and 1.0.

```
ENTER THE ADULT EQUIVALENT HABITAT MULTIPLIER FOR SPAWNING:
```

If only *one* fry age class is being used,

```
ENTER THE ADULT EQUIVALENT HABITAT MULTIPLIER FOR FRY:
```

If *two* fry age classes are being used,

```
ENTER THE ADULT EQUIVALENT HABITAT MULTIPLIERS FOR THE 2
FRY AGE CLASSES - YOUNGEST FIRST:
```

Separate the two responses with a space, comma, or a carriage return.

If *one* juvenile life stage is being used,

```
ENTER THE ADULT EQUIVALENT HABITAT MULTIPLIER FOR JUVENILES:
```

If *two* juvenile life stages are being used,

```
ENTER THE 2 ADULT EQUIVALENT HABITAT MULTIPLIERS FOR THE 2
JUVENILE LIFE STAGES - YOUNGEST FIRST:
```

Separate the two responses with a space, comma, or a carriage return.

If *three* juvenile life stages are being used,

```
ENTER THE 3 ADULT EQUIVALENT HABITAT MULTIPLIERS FOR JUVENILES
YOUNGEST, MIDDLE, THEN OLDEST:
```

Separate the three responses with a space, comma, or a carriage return.

```
ENTER STATION INDEX (8 CHAR):
```

Enter the station ID, using a maximum of 8 characters.

If annual time series files were used as input, the following prompts will appear in addition to those explained above:

```
DATASET IS [——]
```

The following prompts will be repeated for each input ZANTS file. The blank will show the 2 title lines from the input file being considered.

```
ENTER   0 FOR COMPOSITE
        1 FOR MINIMUM
   OR   2 FOR MAXIMUM AS RELEVANT TIME SERIES
```

This prompt refers to the three columns of numbers on the annual time series file. The first column is the composite annual habitat value (average of the maximum and minimum values for the relevant months). The second and third values are the minimum and maximum annual habitat values, respectively. You must choose the index appropriate for the species–life stage.

For example, a maximum value is used for spawning, under the assumption that the spawn will occur at any time within a certain (temperature–flow) window. In contrast, a minimum value may be more appropriate for fry, which are more vulnerable to catastrophic events. For more resilient adults, an average (composite) may be the most appropriate. In any case, you must choose a biologically reasonable response.

```
ENTER   1 TO ADD A YEAR TO THE DATA
        2 TO SUBTRACT A YEAR FROM THE DATA
        0 TO LEAVE THE YEARS UNCHANGED
```

This prompt allows you to ensure that the annual index applies to the correct biological year, where biological year is defined as beginning with the month of the hatch or swimup. You are responsible for defining how you wish to numerically refer to a biological year and making sure that annual index values are synchronized to each biological year for each interdependent life stage. (This is a challenge—an example follows.)

Most monthly habitat time series analyses are performed in a water year format—that is, month 1 is October, month 2 is November, and so forth. October of water year 1960 is really in calendar year 1959. To further complicate matters, the ANNTS program may have changed the year designation based on its algorithm of choosing the year from the greatest number of months considered in the annual index calculation.

Hatch of a *theoretical* fall-spawning species is in March and April. We further assume that the fry life stage may be from March through November, juvenile from December through February, and adults are present all year. The biological year, by definition, will be from March to February. In this case, the fry habitat value from (calendar year [and water year]) 1960 matches the habitat value that should be used to characterize biological year 1960. However, the juvenile habitat value from (calendar year [and water year]) 1960 really applies to biological year 1959. This is because the December through February habitat

value following the hatch is in the next water year. (In addition, ANNTS would have put the habitat values into 1960 because the majority of months, January and February, occur in calendar year 1960.) Thus, you would need to subtract one year from the annual designation for juveniles. Adults, present year round in our example, will not need to be changed. Figure 9.12 diagrams this concept.

All this can be confusing. We recommend that the output from both ANNTS and EFFIN2 be scrutinized to ensure that the biological year is properly characterized and all life stages are synchronized before running the EFFHB2 program. You may need to delete mismatched biological years from certain life stages when you have finished, using a text editor. Totally illogical results are assured if care is not taken.

```
COMPOSITE FILE WITH [—] YEARS WRITTEN.
```

The blank will be filled with the number of years of data written to the output file. The output file should now contain the data in a format that can be read by the EFFHB2 program.

If all data is being entered from the keyboard, the following prompts will appear in addition to those explained above:

```
ENTER FIRST YEAR OF DATA:
```

Enter the year number for the first year of data.

```
ENTER ANNUAL HABITAT DATA:

Enter values for each year in this format:
                              ##########.#.
Separate each value with a space and follow the last value
with a carriage return. When all years of data have been en
tered, type Q to quit.
Year  Adult  Spawning  Swimup  Fingerling  Juvenile
xxxx
```

[xxxx] is the first year number entered in the prompt
Enter first year of data

LPTDAN Program

Introduction

The LPTDAN program reads one or two annual time series files and writes an output file containing an annual duration table showing ordered annual data, a summary statistics table containing average, median, index-A (average of the interval between 50 and 90% duration), index-B (average of the interval between 10 and 90% duration), index-C (a user-defined index), 10%, 20%, 80%, and 90% exceedence, and an exceedence plot.

When two annual time series files are used as input, they do not have to contain the same number of years of data.

Running LPTDAN

RLPTDAN, ZOUT, ZANTS, ZANTS2

ZOUT = LPTDAN results (output).

ZANTS = Annual time series file (input).

ZANTS2 = Second annual time series file (input).

> Input files do not have to contain the same number of years. Multirecord files may be used.

If ZANTS files are from the ANNTS or ANEQTS program:

```
ENTER 0 TO CHOOSE COMPOSITE, MINIMUM, AND MAXIMUM
      VALUES FOR EACH RECORD
      1 TO CHOOSE COMPOSITE, MINIMUM, AND MAXIMUM
      VALUES ONCE FOR ALL RECORDS
```

This prompt refers to the three columns of numbers on the annual time series file from the ANNTS or ANEQTS programs. The first column is the composite annual habitat value (average of the maximum and minimum values for the relevant months). The second and third values are the minimum and maximum annual habitat values, respectively. You must choose the index appropriate for the species–life stage.

For example, a maximum value is used for spawning, under the assumption that the spawn will occur at any time within a certain (temperature–flow) window. In contrast, a minimum value may be more appropriate for fry, which are more vulnerable to catastrophic events. For more resilient adults, an average may be the most appropriate. In any case, you must choose a biologically reasonable response.

If 0 is entered, the following prompt will appear for each record (usually life stages) in the data set.

If 1 is entered, the following prompt will appear once and the same value (composite, minimum, or maximum) will be used for each record in the data set.

```
ENTER 0 TO USE COMPOSITE VALUES
      1 TO USE MINIMUM VALUES, OR
      2 TO USE MAXIMUM VALUES FOR ALL CALCULATIONS
```

If ZANTS files are from the EFFHAB or EFFHB2 programs:

```
ENTER 0 TO CHOOSE AVAILABLE OR EFFECTIVE HABITAT VALUES
        FOR EACH RECORD
      1 TO CHOOSE AVAILABLE OR EFFECTIVE HABITAT VALUES
        ONCE FOR ALL RECORDS
```

This prompt refers to the two columns of numbers on the annual time series file from the EFFHAB and EFFHB2 programs. The first column is the available annual habitat value and the second is the effective annual habitat value. You must choose the value you wish to plot.

If 0 is entered, the following prompt will appear for each record (usually life stages) in the data set.

If 1 is entered, the following prompt will appear once and the same value (available or effective) will be used for each record in the data set.

```
ENTER 0 TO USE AVAILABLE HABITAT VALUES, OR
      1 TO USE EFFECTIVE HABITAT VALUES FOR ALL CALCULATIONS.

ENTER TABLE LABEL FOR FIRST SET (UP TO 14 CHAR):
```

The program will display the first two lines of the first data set for user identification. The label should identify the data set and will appear on the output tables. If two data sets were specified as input, the same prompt will appear for the second data set.

```
LPTDAN WILL COMPUTE INDEX-A (50-90%) AND INDEX-B (10-90%)

ENTER 1 TO DEFINE AN INDEX-C, 0 OTHERWISE.
```

Index-C may be useful if the exceedence values described by index-A and index-B are irrelevant to your application or do not cover the percentages of interest. For example, if the events in the 90–100% exceedence category are thought to be important population limiting events, then you may wish to define index-C as covering the 90–100% exceedence category.

If 1 is entered to define an index-C:

```
ENTER THE LOWER AND UPPER BOUNDARIES FOR INDEX-C:
ENTER 1 TO WRITE DURATION TABLE(S), 0 OTHERWISE.
```

These are tables showing ordered annual data.

```
ENTER 1 FOR DURATION PLOT(S), 0 OTHERWISE
```

These are annual exceedence plots.

If tables or plots are to be written:

```
ENTER PLOT & DURATION TABLE TITLE LINE (UP TO 70 CHAR):
```

This title will appear below the X-axis on plots and above each duration table.

```
ENTER 1 FOR LOG-LINEAR PLOT, 0 FOR LINEAR-LINEAR.
```

The Y-axis will represent the data values. Enter "1" for the X-axis on a log scale, or "0" for the X-axis on a linear scale.

The following prompt will appear if the linear–linear plotting option is chosen. For log–linear, the X-axis will automatically begin at the minimum X data value.

```
ENTER 0 FOR X-AXIS TO BEGIN AT 0,
ENTER 1 TO BEGIN AT MINIMUM X-DATA VALUE.
ENTER X-AXIS LABEL (UP TO 10 CHARACTERS)
```

This X-axis label will appear on the exceedence plot. The label should describe the type of input data, and possibly the units.

Figure 9.14 contains sample output from the LPTDAN program.

```
DATE - 90/06/06.                                                                  PROGRAM - LPTDAN
TIME - 15.28.42.                                                                    PAGE -     1

FIRST DATA SET IS -

SNOQUALMIE RIVER
   FRY      RAINBOW TROUT

                 ANNUAL TIME SERIES - COMPOSITE VALUES

  YEAR      VALUE      YEAR      VALUE      YEAR      VALUE      YEAR      VALUE

  1971    14211.30     1972    14561.70     1973    16685.00     1974    14378.30
  1975    14737.70     1976    16016.40     1977    17336.20     1978    17334.10
  1979    16752.80     1980    17028.30     1981    15907.10


ANNUAL HABITAT TIME SERIES ANALYSIS - 1971-82

          ORDERED ANNUAL DATA - COMPOSITE VALUES

                   PRE-PROJECT
   ORDER                              PLOTTING
  NUMBER     YEAR      ELEMENT         POINT

     1       1977     17336.20          4.55
     2       1978     17334.10         13.64
     3       1980     17028.30         22.73
     4       1979     16752.80         31.82
     5       1973     16685.00         40.91
     6       1976     16016.40         50.00
     7       1981     15907.10         59.09
     8       1975     14737.70         68.18
     9       1972     14561.70         77.27
    10       1974     14378.30         86.36
    11       1971     14211.30         95.45
```

Fig. 9.14. Sample output from the LPTDAN program. Only the output for rainbow trout—fry has been included in this sample output.

```
DATE - 90/06/06.        SNOQUALMIE RIVER                                   PROGRAM - LPTDAN
TIME - 15.28.42.          FRY      RAINBOW TROUT                                  PAGE -    3

         SUMMARY STATISTICS FOR 1971 THRU 1981 - COMPOSITE VALUES

                    PRE-PROJECT

        AVERAGE =     15904.445              0.000

         MEDIAN =     16016.400              0.000

        INDEX-A =     15032.231              0.000

        INDEX-B =     15933.748              0.000

        INDEX-C =     14947.046              0.000 ***
     10 PERCENT =     17334.939              0.000

     20 PERCENT =     17120.041              0.000

     80 PERCENT =     14506.680              0.000

     90 PERCENT =     14311.500              0.000

      *** INDEX-C IS THE AVERAGE PERCENTAGE EXCEEDENCE
          BETWEEN:       50.00 AND      95.00
```

```
DATE - 90/06/06.        SNOQUALMIE RIVER                                   PROGRAM - LPTDAN
TIME - 15.28.42.          FRY     RAINBOW TROUT                                   PAGE -    4
```

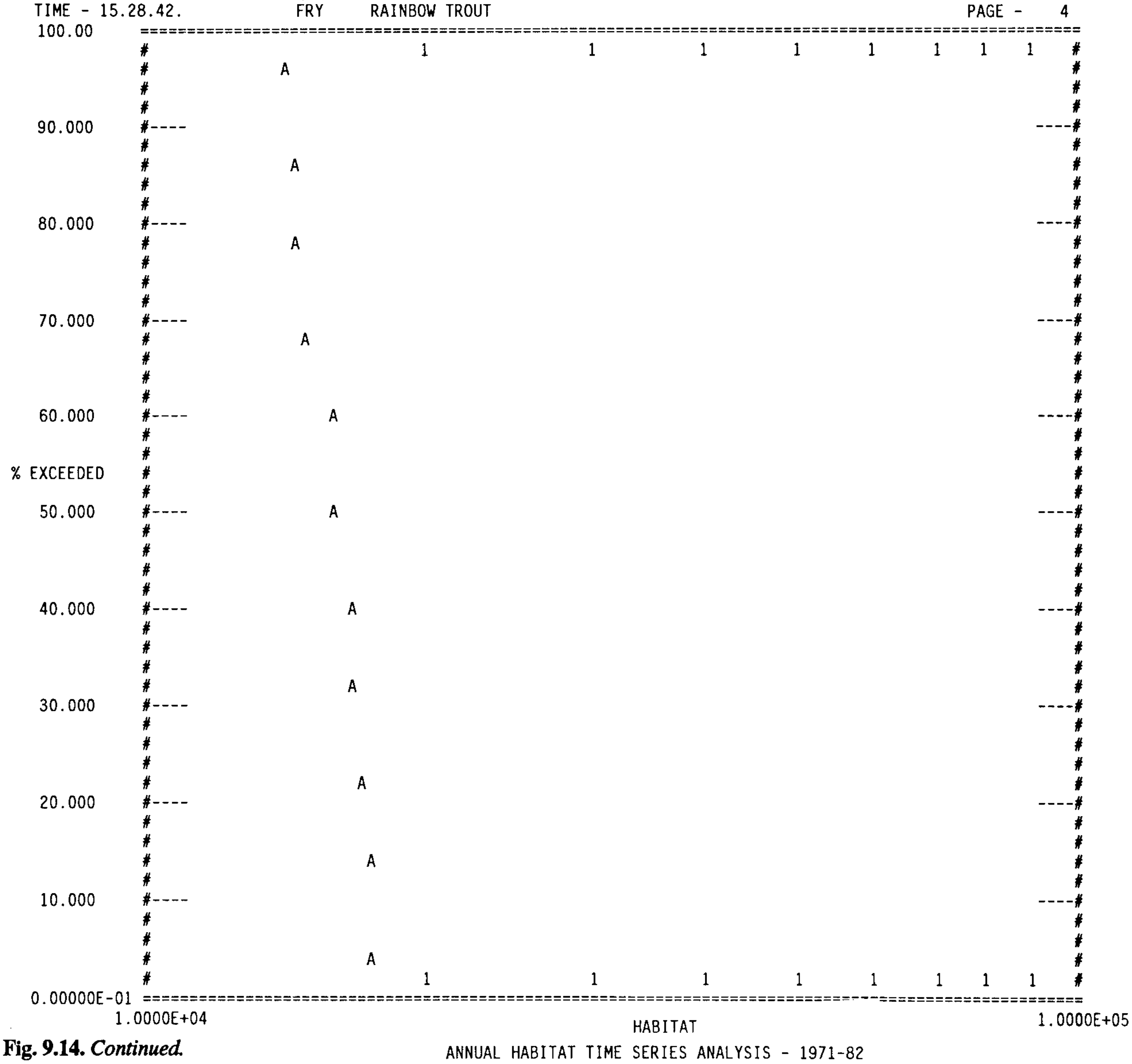


Fig. 9.14. *Continued.*

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Appendix A. Sample File Formats

Name | Page

A multirecord file has the following format requirements:

1. The record names must be 1- to 7-character names, constructed from the characters a–z, A–Z, and 0–9. Other characters may be legal for MS-DOS applications but will not be legal for CDC implementations.The record name will be the first 7 characters on the first line.

2. The end-of-record marks may be either #EOR or #eor and must be the first 4 characters on a line. This special end-of-record mark is required so that transfer of this data file using the CDC CONNECT software from microcomputers to CDC mainframes will work properly. Conversely, a standard CDC multirecord data file will contain these same characters if transferred from the mainframe to micro using CONNECT. CONNECT is a copyrighted program available for free distribution to CDC users.

3. The data comprising the text data must be standard ASCII lines ≤ 32,767 characters in length, terminated by a carriage return–line feed sequence. (To conform to CDC standards, however, we recommend that a line be no longer than 136 characters.) Any ASCII editor will create such a file.

Daily Streamflow File in WATSTORE Format

ZDQ = default filename
DQ.DAT = sample file on disk

```
H 12142000          4736541214244005353033SW17110010  64.00          1130.00
N 12142000          N.F. SNOQUALMIE RIVER NR SNOQUALMIE FALLS, WA.
  12142000                 0006000003                 ENT
3 12142000          19701001 138.00 129.00 120.00 116.00 431.00 324.00 230.00 205.00
3 12142000          197010021370.00 766.00 456.00 496.00 362.00 288.00 248.00 218.00
3 12142000          19701003 198.00 205.00 312.00 362.00 468.00 468.00 710.00 740.00
3 12142000          19701004 444.00 330.00 273.00 245.00 222.00 209.00 196.00
3 12142000          19701101 187.00 183.00 172.00 158.00 152.00 183.00 172.00 270.00
3 12142000          19701102 448.00 297.00 365.001260.00 700.00 424.00 386.001020.00
3 12142000          19701103 620.00 715.00 720.00 665.00 456.00 348.001310.003090.00
3 12142000          197011041140.00 665.00 508.00 400.00 340.00 312.00
3 12142000          19701201 282.00 260.00 240.00 225.00 592.002550.002330.00 975.00
3 12142000          19701202 606.00 588.00 700.00 476.00 393.00 348.00 351.00 350.00
3 12142000          19701203 310.00 266.00 250.00 230.00 210.00 200.00 190.00 177.00
3 12142000          19701204 165.00 165.00 165.00 180.00 260.00 400.00 450.00
3 12142000          19710101 260.00 220.00 196.00 178.00 169.00 158.00 172.00 500.00
3 12142000          197101021270.00 960.00 600.00 382.00 315.00 273.00 394.00 814.00
3 12142000          197101031030.001070.004050.001380.00 796.00 675.001310.001380.00
3 12142000          197101041020.002380.001550.00 916.00 680.001580.002390.00
3 12142000          197102011380.00 947.00 705.00 588.00 480.00 412.00 372.00 340.00
3 12142000          19710202 358.001970.001740.001310.002270.001770.001930.001080.00
3 12142000          19710203 740.00 640.00 530.00 460.00 440.00 420.00 405.00 580.00
3 12142000          19710204 460.00 380.00 340.00 308.00
3 12142000          19710301 282.00 280.00 270.00 250.00 235.00 220.00 320.00 300.00
3 12142000          19710302 270.00 380.00 560.00 500.00 410.00 355.00 310.00 285.00
3 12142000          19710303 265.00 240.00 234.00 227.00 215.00 225.00 450.00 760.00
3 12142000          19710304 500.00 450.00 410.00 380.00 920.001100.00 690.00
3 12142000          19710401 500.00 436.00 379.00 368.00 448.00 620.00 565.00 529.00
3 12142000          19710402 610.00 601.00 480.00 400.00 372.00 412.00 448.00 382.00
3 12142000          19710403 330.00 306.00 288.00 324.00 327.00 300.00 300.00 309.00
3 12142000          19710404 306.00 534.00 725.00 645.00 560.00 524.00
3 12142000          19710501 730.001230.001500.001310.00 968.00 778.001030.001300.00
3 12142000          197105021010.00 947.001260.001670.001580.001030.00 740.00 880.00
3 12142000          19710503 725.00 601.00 954.00 975.00 730.00 820.001000.001130.00
3 12142000          197105041230.001200.001280.001280.001210.00 904.00 665.00
3 12142000          19710601 601.00 625.00 665.00 685.00 635.00 750.001060.00 975.00
3 12142000          19710602 745.00 808.00 947.00 820.00 910.001410.00 996.00 772.00
3 12142000          19710603 675.00 772.001140.001030.001120.001420.001240.00 868.00
3 12142000          197106041270.00 868.00 685.00 630.00 556.00 583.00
3 12142000          19710701 610.00 542.00 588.00 625.00 601.00 710.00 592.00 552.00
3 12142000          19710702 820.001110.00 910.00 750.00 745.00 838.00 947.00 922.00
3 12142000          19710703 838.00 968.001020.00 940.00 838.00 725.00 650.00 583.00
3 12142000          19710704 583.00 606.00 556.00 529.00 542.00 516.00 476.00
3 12142000          19710801 428.00 340.00 297.00 276.00 270.00 260.00 250.00 245.00
3 12142000          19710802 225.00 207.00 194.00 183.00 168.00 156.00 144.00 132.00
3 12142000          19710803 123.00 116.00 113.00 113.00 116.00 170.00 148.00 120.00
3 12142000          19710804 108.00 102.00  96.00  92.00  89.00  89.00 112.00
3 12142000          19710901 152.00 677.00 488.00 258.00 238.00 372.00 230.00 185.00
3 12142000          19710902 183.00 160.00 230.00 200.00 160.00 138.00 123.00 113.00
3 12142000          19710903 105.00  98.00  94.00  89.00  86.00  82.00  80.00  87.00
3 12142000          19710904 185.00 136.00 148.00 432.00 452.00 270.00
```

Monthly Streamflow File in NWDC Format

ZMONQ = default filename
NWDC.DAT = sample file on disk

```
NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH                       1214200000
MEAN MONTHLY DISCHARGE - 1962 THRU 1977
12142000      1962 1      523      479      715      865      363      243
12142000      1962 2      709      510      568      318      281      197
12142000      1963 1      300      721      748      421      686      314
12142000      1963 2      523      456      394      247      125      149
12142000      1964 1      315      751      549      668      380      412
12142000      1964 2      533      846     1219      692      439      405
12142000      1965 1      365      568      742      920      771      329
12142000      1965 2      637      587      461      222      146      243
12142000      1966 1      352      475      429      543      275      472
12142000      1966 2      666      798      599      424      120       78
```

Monthly Streamflow File in USGS Format

ZMONQ = default filename
USGS.DAT = sample file on disk

```
NORTH FORK SNOQUALMIE RIVER NEAR SNOQUALMIE FALLS WASH                       1214200000
MEAN MONTHLY DISCHARGE - 1962 THRU 1977
3        121420001962    1 523.00 479.00 715.00 865.00 363.00 243.00
3        121420001962    2 709.00 510.00 568.00 318.00 281.00 197.00
3        121420001963    1 300.00 721.00 748.00 421.00 686.00 314.00
3        121420001963    2 523.00 456.00 394.00 247.00 125.00 149.00
3        121420001964    1 315.00 751.00 549.00 668.00 380.00 412.00
3        121420001964    2 533.00 846.00    1219 692.00 439.00 405.00
3        121420001965    1 365.00 568.00 742.00 920.00 771.00 329.00
3        121420001965    2 637.00 587.00 461.00 222.00 146.00 243.00
3        121420001966    1 352.00 475.00 429.00 543.00 275.00 472.00
3        121420001966    2 666.00 798.00 599.00 424.00 120.00  78.00
```

Habitat Area-versus-Streamflow File

ZHAQF = default filename
HAQF.DAT = sample file on disk

```
SNOQUALMIE RIVER
NEAR SNOQUALMIE FALLS, WA
RAINBOW TROUT
      DISCHARGE      FRY          JUVENILE     ADULT
          10.00    20570.00       8220.00     5780.00
         100.00    15400.00       4770.00     3200.00
         150.00    18880.00       7230.00     4890.00
         200.00    19790.00       9360.00     6410.00
         250.00    19780.00      11470.00     8020.00
         300.00    19110.00      13140.00     9410.00
         350.00    18050.00      14110.00    10400.00
         400.00    16290.00      15850.00    12600.00
         500.00    14470.00      16360.00    13660.00
         600.00    11030.00      14610.00    13380.00
         800.00     9090.00      12310.00    11740.00
        1000.00     7410.00       9270.00     8880.00
        1500.00     6940.00       8490.00     7620.00
        2000.00     7210.00       8630.00     7810.00
        4000.00     6660.00       9480.00     8510.00
        6000.00     5740.00       9890.00     9670.00
***************
```

Monthly Habitat Time Series File
(Multirecord file in NWDC format)

ZMTS = default filename
MTS.DAT = sample file on disk

```
CLASSA1
SNOQUALMIE RIVER
   FRY     RAINBOW TROUT
12142000    1971 1     16894     14585     16598     12035     12444     16865
12142000    1971 2     15501      8019      9006     10400     17841     17452
12142000    1972 1     16294     12313     15399     15073     11639      9344
12142000    1972 2     12353      8409      8325     12460     18655     15320
12142000    1973 1     17872     16138     13202     16229     18966     19033
12142000    1973 2     17418     14164     14600     17977     17492     17434
#EOR
CLASSA2
SNOQUALMIE RIVER
  JUVENILE RAINBOW TROUT
12142000    1971 1     11761     12041     11761     10643     12995     12959
12142000    1971 2     14707     10262     11720     13246      8165      8814
12142000    1972 1     10550     14077     13141     13486     11449     10875
12142000    1972 2     13863     10354     10751     13459      8464      8327
12142000    1973 1      7892     11082      9920     12329      9651     11976
12142000    1973 2     13516     14539     14240      7768      6166      8132
#EOR
CLASSA3
SNOQUALMIE RIVER
   ADULT   RAINBOW TROUT
12142000    1971 1      9010      9791      9071      9020     10944     10009
12142000    1971 2     11900      9625     10945     12098      5691      6400
12142000    1972 1      8094     12206     10433     10772      9810      9675
12142000    1972 2     11920      9470     10102     11600      5823      6294
12142000    1973 1      5479      8662      8123      9568      6827      8630
12142000    1973 2     10340     12099     11776      5337      4244      5910
#EOR
```

Annual Habitat Time Series File

ZANTS = default filename
ANTS.DAT = sample file on disk

(Multirecord File)

```
CLASSA1
SNOQUALMIE RIVER
   FRY      RAINBOW TROUT
A 12142000  1971         14211.3        9006.0         17841.0
A 12142000  1972         14561.7        8325.0         18655.0
A 12142000  1973         16685.0       14600.0         17977.0
A 12142000  1974         14378.3        7804.0         18474.0
A 12142000  1975         14737.7        9786.0         17229.0
A 12142000  1976         16016.4       12494.0         18238.0
A 12142000  1977         17336.2       15855.0         17876.0
A 12142000  1978         17334.1       16031.0         18622.0
A 12142000  1979         16752.8       15320.0         17188.0
A 12142000  1980         17028.3       15625.0         18762.0
A 12142000  1981         15907.1       11700.0         19105.0
#EOR
CLASSA2
SNOQUALMIE RIVER
  JUVENILE RAINBOW TROUT
A 12142000  1971         10502.0        8165.0         13246.0
A 12142000  1972          9781.7        7892.0         13459.0
A 12142000  1973          9421.4        6166.0         14240.0
A 12142000  1974          9306.1        6025.0         13166.0
A 12142000  1975         10600.1        7595.0         12469.0
A 12142000  1976         10850.5        7163.0         13878.0
A 12142000  1977          9571.4        6922.0         12536.0
A 12142000  1978         10327.8        7193.0         14229.0
A 12142000  1979          9050.7        5824.0         14295.0
A 12142000  1980          9793.3        6585.0         14608.0
A 12142000  1981          9707.1        5650.0         13070.0
#EOR
CLASSA3
SNOQUALMIE RIVER
   ADULT    RAINBOW TROUT
A 12142000  1971          8645.2        5691.0         12098.0
A 12142000  1972          7855.2        5479.0         11600.0
A 12142000  1973          7133.3        4244.0         11776.0
A 12142000  1974          7580.0        4108.0         12147.0
A 12142000  1975          8561.0        5384.0         11463.0
A 12142000  1976          8490.2        5067.0         11969.0
A 12142000  1977          7094.0        4701.0          9908.0
A 12142000  1978          7690.3        4899.0         11148.0
A 12142000  1979          6785.6        3988.0         11583.0
A 12142000  1980          7271.8        4472.0         11736.0
A 12142000  1981          7495.5        3836.0         11392.0
#EOR
```

ZHABIN File Used as Input to the HABNET Program
(Created by the HABINN Program)

ZHABIN = default filename
HABIN.DAT = sample file on disk

```
POUDRE RIVER TOTAL NETWORK ANALYSIS
TEMP FORMAT 1
ENGLISH UNITS
WY:KSQFT
FIRST YEAR OF DATA   1954
LAST YEAR OF DATA    1983
MONTHS              111111111111
1 SEG 1.5            8.0
1 SEG 1.4           38.0
1 SEG 1.1            6.3
1 SEG 2.2            4.9
1 SEG 3.3            5.1
1 SEG 4.1            1.0
1 SEG 4.2            6.3
**********
1 BROWN     ADULT
1 BROWN     JUVENILE
1 BROWN     FRY
1 BROWN     SPAWNING
1 RAINBOW   ADULT
1 RAINBOW   JUVENILE
1 RAINBOW   FRY
1 RAINBOW   SPAWNING
**********
```

Sample ZHABIN file used as input to HABNET.

File Format for a ZHABIN File (HABNET Input File)

Line 1: This title line will be written to the habitat time series file (ZMTS) and output file (ZOUT) from HABNET.

Line 2: Temperature suitability file format being used as input (ZTSI file):
0 = No temperature suitability index file,
1 = Network temperature suitability index file,and
2 = FISHCRV file with temperature criteria.

Line 3: Units flow data and segment lengths are in
METRIC UNITS or
ENGLISH UNITS.

Line 4: This line is for reference, and the information will appear in the HABNET output. These values are not used in the HABNET calculations.

Columns:	
1–3	Time codes (with a trailing :) For example, AY: = agricultural year, CY: = calendar year, WY: = water year, and = blank.
4–10	Measurement units codes (left-justified)—KSQFT or KSQM
11–80	Blank—may be used for comments.

Line 5: The first year of data to be processed from the gaging station flow data file (ZMTSM).

Columns	Format	Description
1–21		FIRST YEAR OF DATA (program does not care what is entered in these columns)
22–25	I4	Year number for first year of data to be processed from ZMTSM file
26–80		Blank—may be used for comments

Line 6: The last year of gaging data to process from the ZMTSM file.

Columns	Format	Description
1–21		LAST YEAR OF DATA (program does not care what is entered in these columns)
22–25	I4	Year number for last year of data to be processed from ZMTSM file
26–80		Blank—may be used for comments.

Line 7: Twelve time period flags—these 12 flags refer to the months of gaging station data. If 1, that month will be processed; if 0, that month will be skipped. The months are in the order specified by the units (calendar year or water year).

Columns	Format	Description
1–20		MONTHS (program does not care what is entered in these columns)
21–32	A12	Processing indicator: 1 = process this month, 0 = do not process this month.
33–80		Blank—may be used for comments.

Lines 8–N: Gaging station/segment information: One line of information for each gaging station–segment.

Columns	Format	Description
1	A1	Processing indicator: 1 = process this segment 0 = do not process this segment
2		Blank
3–10	8 Characters	Segment ID
11–20		Blank—may be used for comments.
21–27	F10.2	Segment length
28–80		Blank—may be used for comments.

End-of-gaging station/segment indicator: Enter a line of 10 asterisks (**********) in columns 1–10 to indicate end of gaging station–segment information.

Species/life stage information: One line of information for each species–life stage.

Columns	Format	Description
1	A1	Processing indicator: 1 = process this species–life stage, 0 = do not process this species–life stage.
2		Blank
3–12	10 Characters	Species name (left-justified)
13–22	10 Characters	Life stage name (left-justified)
23–80		Blank—may be used for comments.

End-of-species/life stage indicator: Enter a line of 10 asterisks (**********) in columns 1–10 to indicate end of species–life stage information.

Modified ZMTS File Used as Input to the HABNET Program

(Modifications Done with an Editor)

ZMTSM = default filename
MTSM.DAT = sample file on disk

> Note: The ZTEMP file (temperature time series data in USGS or NWDC format) is in the same format as the ZMTSM file, except it contains temperature data instead of flow data.

```
NETWORK GAGING STATION DATA CACHE LA POUDRE - USGS FORMAT
MEAN MONTHLY FLOWS (CFS)
POUDRE RIVER SEGMENT 1 SITE 5 FLOWS (NOTE: SAME FLOW THRU 1)
Q        SEG 1.5 1954  1  20.00  17.00  16.00  19.00  13.00   6.00
Q        SEG 1.5 1954  2  38.00    492    534    228  75.00    101
Q        SEG 1.5 1955  1  55.00  14.00   7.00  15.00   8.00   5.00
Q        SEG 1.5 1955  2   9.00    451    882    401    248  65.00
Q        SEG 1.5 1956  1  32.00  25.00  32.00  24.00  19.00  19.00
Q        SEG 1.5 1956  2  34.00   1056   1367    342    168  95.00
Q        SEG 1.5 1957  1  26.00  19.00  17.00  17.00  16.00  13.00
Q        SEG 1.5 1957  2  21.00    227   1689   1545    445    323
Q        SEG 1.5 1958  1  38.00  25.00  19.00  16.00  17.00  17.00
Q        SEG 1.5 1958  2  26.00    733   1317    375    219    141
Q        SEG 1.5 1959  1  56.00  18.00  15.00  14.00  13.00  14.00
Q        SEG 1.5 1959  2  22.00    305   1479    528    283    176
Q        SEG 1.5 1960  1  47.00  35.00  25.00  19.00  18.00  21.00
Q        SEG 1.5 1960  2  91.00    570   1483    552    228    161
Q        SEG 1.5 1961  1  31.00  20.00  18.00  18.00  15.00  13.00
Q        SEG 1.5 1961  2  17.00    366   1181    443    298    238
Q        SEG 1.5 1962  1    116  61.00  57.00  36.00  30.00  26.00
Q        SEG 1.5 1962  2    153    821   1125    731    319    188
Q        SEG 1.5 1963  1  34.00  14.00  10.00   9.00  10.00  11.00
Q        SEG 1.5 1963  2  30.00    498    678    317    262    164
POUDRE RIVER SEGMENT 1 SITE 4 FLOWS (NOTE: FLOWS SAME AS 1.5)
         SEG 1.4  DITTO FROM SEG 1.5
POUDRE RIVER SEGMENT 1 SITE 1 FLOWS (NOTE: FLOWS FROM 2.2)
Q        SEG 1.1 1954  1  55.00  33.00  33.00  32.00  28.00  25.00
Q        SEG 1.1 1954  2  49.00    414    574    245  61.00  96.00
Q        SEG 1.1 1955  1  81.00  28.00  17.00  20.00  16.00  20.00
Q        SEG 1.1 1955  2  33.00    356   1016    455    252  73.00
Q        SEG 1.1 1956  1  50.00  39.00  40.00  28.00  25.00  31.00
Q        SEG 1.1 1956  2  58.00   1174   1456    396    188  54.00
Q        SEG 1.1 1957  1  33.00  20.00  26.00  21.00  24.00  23.00
Q        SEG 1.1 1957  2    118    573   2272   1687    328    162
Q        SEG 1.1 1958  1  81.00  45.00  43.00  34.00  37.00  43.00
Q        SEG 1.1 1958  2    182   1497   1602    262  66.00  54.00
Q        SEG 1.1 1959  1  51.00  31.00  33.00  27.00  36.00  50.00
Q        SEG 1.1 1959  2    202    712   1730    400    175  68.00
Q        SEG 1.1 1960  1  73.00  63.00  19.00  17.00  14.00  49.00
Q        SEG 1.1 1960  2  93.00    810   1613    450    105  71.00
Q        SEG 1.1 1961  1  49.00  29.00  25.00  37.00  30.00  46.00
Q        SEG 1.1 1961  2    132   1142   1963    520    305    196
Q        SEG 1.1 1962  1    264    113  52.00  59.00    103  88.00
Q        SEG 1.1 1962  2    322   1121   1427    748    184  37.00
Q        SEG 1.1 1963  1  62.00  35.00  29.00  18.00  19.00  12.00
Q        SEG 1.1 1963  2  67.00    444    635    199    190    124
POUDRE RIVER SEGMENT 2 SITE 2 FLOWS
         SEG 2.2  DITTO FROM SEG 1.1
```

Sample ZMTSM file in NWDC format.

File Format for a ZMTSM File

Lines 1 and 2: Title lines (80 characters per line)

Line 3: Gaging station–segment identifier

Lines 4 through N: Option 1—Flow data. There are 2 lines for each year of flows, formatted as follows:

Columns	Format	Description
(USGS Format)		
9–16	A8	Segment ID number
17–20	I4	Year
24	I1	Data indicator: 1 = first set (months 1–6), 2 = second set (months 7–12).
25–66	6F7.0	Flows

Columns	Format	Description
(NWDC Format)		
1–8	A8	Segment ID number
13–16	I4	Year
17		Blank
18	I1	Data indicator: 1 = first set (months 1–6), 2 = second set (months 7–12).
20–67	6F8.0	Flows

Lines 4 through N: Option 2—For networks in which flows do not change appreciably through a river segment, but the habitat-versus-flow relations do change due to geomorphic features, there is a "ditto" option. (This line comes after a line with the segment ID). If the first line of flow data is

Columns	Format	Description
(USGS Format)		
9–16	A8	Segment ID number
17		Blank
18–27	A10	DITTO FROM (upper case)
28		Blank
29–36	A8	Segment ID number (segment from which to be copied).

Columns	Format	Description
(NWDC Format)		
1–8	A8	Segment ID number
9		Blank
10–19	A10	DITTO FROM (upper case)
20		Blank
21–28	A8	Segment ID number (segment from which to be copied)

the flow data will be copied from the segment ID entered. Note that DITTO can be applied to a previously DITTOed segment—that is, suppose the file looks like this:

```
 SEGMENT1
flow data
 SEGMENT2
flow data
 SEGMENT3
flow data
 SEGMENT4 DITTO FROM SEGMENT3
 SEGMENT5 DITTO FROM SEGMENT4
```

then both segments 4 and 5 would have the same flow data as segment 3. (Segment 5 could have said DITTO FROM SEGMENT3). In any case, DITTO may only refer to a segment previously encountered in the file.

Lines 4 through N: Repeat for each new gaging station–segment.

Modified ZHAQF File Used as Input to the HABNET Program

(Modified Using the HQFMON Program)

ZHAQFM = default filename
HAQFM.DAT = sample file on disk

```
CACHE LA POUDRE RIVER FLOW VS. HABITAT (WUA SQ.  FT PER FT.) FUNCTIONS
SECOND MAIN TITLE LINE
POUDRE RIVER SEGMENT 1 SITE 5
SEG 1.5
BROWN                         111111111111   0.0
      DISCHARGE  ADULT
           0.00           0.
          25.00       13000.
          50.00       16500.
         100.00       19400.
         200.00       19000.
         300.00       15000.
         500.00       10000.
         700.00        7900.
         900.00        6400.
        1000.00        5800.
        2000.00        4100.
        3000.00        4000.
        5000.00        4000.   Arbitrarily extended
**********
POUDRE RIVER SEGMENT 1 SITE 5
SEG 1.5
BROWN                         111111111111   0.0
      DISCHARGE  JUVENILE
           0.00           0.
          25.00       15000.
          50.00       21000.
         100.00       28000.
         200.00       25700.
         300.00       20200.
         500.00       14200.
         700.00       10200.
         900.00        7400.
        1000.00        7000.
        2000.00        4100.
        3000.00        3500.
        5000.00        3500.   Arbitrarily extended
**********
POUDRE RIVER SEGMENT 1 SITE 5
SEG 1.5
BROWN                          000000011110  0.0
      DISCHARGE  FRY
           0.00           0.
          25.00        7200.
          50.00       11200.
         100.00       13900.
         200.00       13000.
         300.00        9500.
         500.00        5900.
         700.00        4700.
         900.00        3600.
        1000.00        3100.
        2000.00        2500.
        3000.00        2400.
        5000.00        2400.   Arbitrarily extended
**********
```

Sample ZHAQFM file.

File Format for a ZHAQFM File

Lines 1 and 2: Title lines (maximum 80 characters per line).

Line 3: Extra title line (optional). Other PHABSIM applications may require that this title line be deleted.

Line 4: Gaging station/segment identifier. This will have to match exactly with the segment numbers read from the gaging station data (ZMTSM) file and the HABNET input file (ZHABIN). Again, other PHABSIM applications may require that this line be deleted.

Line 5: Species data line.

Columns	Format	Description
1–10	10 Characters	Species name
11–29		Blank
30–41	A12	12 time period flags: 1 if applicable, 0 if not. These values are necessary at all segments; the order depends on whether it is a water year or calendar year.
42		Blank
43–52	F10.0	Habitat threshold—that value (in square feet × 1,000, for example) under which a warning error will be printed if the population's usable area falls below it for any month.
53–80		Blank

Line 6: Discharge and life stage data line.

Columns	Format	Description
1–6		Blank
7–15	9 Characters	DISCHARGE
16–17		Blank
18–27	10 Characters	Life stage name
28–80		Blank

Lines 7 through N: Discharge and weighted usable area data (3X, 2F12.0) followed by line N + 1 which is **********, end of logical record.

Repeat lines 3–N for each species–life stage in the file. The format repeats for each new segment. The time and threshold are required for each segment because they may differ throughout the network—that is, a life stage may have different time and threshold values at different geographic points.

ZTEMP File Used as Input to the HABNET Program

(Optional Input) This file may be in two formats:

(1) USGS or NWDC format—modifications done with an editor.

> Note: The ZTEMP file (temperature time series data in USGS or NWDC format) is in the same format as the ZMTSM file except that it contains temperature data instead of flow data.

(2) Free-formatted file containing parameters for a temperature-versus-flow relation. This file can be created with the QTEM program or with an editor. Type INFOTQ for on-line information on the format of this file.

ZTEMP = default filename

TEMP1.DAT = sample temperature time series data in NWDC format on disk

File Format for a Free-formatted ZTEMP File (Can be Created by the QTEM Program or with an Editor)

Lines 1-3: Title lines for data

Line 4: The letters TQ (upper case) in columns 1 and 2.

Line 5: Segment ID number (maximum 8 characters). These numbers will have to match exactly with the segment numbers read from the gaging station data (ZMTSM) file, the HABNET input file (ZHABIN), and the habitat area-versus-flow relation file (ZHAQFM).

Lines 6 through 17: Empirically derived parameters to calculate temperature as a function of flow for each of the 12 time steps per year at each geographic location. Enter one line for each time period containing the number of the time period and the four empirically derived temperature versus flow parameters (a, b, c, d).

The formulation is:

$$T_i = a_i + b_i \log Q_i + c_i Q^{d_i}$$

where

T_i = calculated temperature for time step i
a_i, b_i, c_i, d_i = empirically derived coefficients for time step i
$\log Q_i$ = natural log (base e) or discharge Q for time step i

The B-coefficient term will only be valid down to flows of 1 (cfs or cms). If flows are below 1, the whole term will drop out of the temperature calculation equation. In other words, we really have a set of equations that looks like the following:

If $Q \geq 1$,

$$T = a + b \ln(Q) + c\, Q^d.$$

If $Q < 1$,

$$T = a + c\, Q^d.$$

Line 18: ********** (10 asterisks) to mark the end of a record.

Lines 19-N: Repeat the segment and flow parameters line (lines 5–18) for each segment.

```
Temperature (F) versus flow (cfs) file for Poudre River Network
Water year organization
Data from SSTEMP approximations (Temperature predictions in Degrees F)
TQ
SEG 1.5
   1     40.660      1.470      0.000      0.000
   2     22.920      3.700      0.000      0.000
   3     22.300      3.510      0.000      0.000
   4     22.160      3.470      0.000      0.000
   5     22.690      3.630      0.000      0.000
   6     27.860      3.080      0.000      0.000
   7     37.620      1.850      0.000      0.000
   8     58.000     -0.610      0.000      0.000
   9     70.230     -2.000      0.000      0.000
  10     74.600     -2.490      0.000      0.000
  11     69.320     -1.900      0.000      0.000
  12     55.080     -0.270      0.000      0.000
**********
SEG 3.3
   1     48.330      0.540      0.000      0.000
   2     30.500      2.740      0.000      0.000
   3     22.870      3.690      0.000      0.000
   4     22.720      3.640      0.000      0.000
   5     27.180      3.160      0.000      0.000
   6     35.220      2.150      0.000      0.000
   7     51.050      0.210      0.000      0.000
   8     64.850     -1.400      0.000      0.000
   9     77.070     -2.750      0.000      0.000
  10     81.700     -3.240      0.000      0.000
  11     76.650     -2.710      0.000      0.000
  12     62.660     -1.150      0.000      0.000
**********
```

Sample free-formatted ZTEMP file created with an editor.

ZTSI File Used as Input to the HABNET Program

(Optional Input) This file may be in two formats:

(1) FISHCRV format—created with the GCURV program in PHABSIM, or
(2) Free-formatted file, containing preference curve data for each life stage. This file is created with an editor. Type INFOTSI for on-line information on the format of this file.

ZTSI = default filename

TSI.DAT = sample free-formatted file with temperature suitability index criteria on disk

Note that the free-formatted temperature data are not in standard PHABSIM FISHCRV data format. It was decided that it would be better to have the chosen format for the following reasons: Few use the temperature data in a FISHCRV file; this format is easier to edit and visually comprehend; there are no restrictions such as including a zero and a 100 coordinate pair (however, it is still wise to do so); and other things, such as the adjustment factor, may be added. This file contains preference curve data for each life stage. The data file is organized with one life stage per record (record, as used here, means life stage), with records separated by at least 10 asterisks (**********). A sample free-formatted ZTSI file, which may be used as input to HABNET, follows.

File Format for a Free-formatted ZTSI File (Created with an Editor)

Line 1: Title line (up to 80 characters)

Line 2: Species and life stage data:

Columns	Format	Description
1–10	10 Characters	Species name (left-justified)
11–20	10 Characters	Life stage name (left-justified)
21–25		Blank
26–28	3 Characters	MIN, AVG, or MAX (see following Note)
29		Blank
30–39	F10.0	Temperature adjustment factor

Lines 3 through N: Temperature and SI data. One line for each temperature, in ascending order, with:

Columns	Format	Description
1–9	F9.0	Temperature
10–11		Blank
12–14	F3.0	Suitability index between 0.0 and 1.0

Line N + 1: Logical end of record (**********)

Lines 2 through N + 1: Repeat for each new species–life stage.

Note: The MIN, AVG, or MAX label is not required for the HABNET program. It is required for compatability with other network programs and it is required that you know what temperatures are supplied or calculated. The adjustment factor allows the addition of a constant value to the calculated or supplied temperature. For example, suppose you had reason to believe that a given life stage could locate a microthermal habitat area that was 2° cooler than the main channel temperature. Supplying a −2 in the temperature adjustment field would then subtract 2° from the supplied or calculated temperature.

> Note: A format of Fx.0 means that you may either right-justify an integer or add a decimal. Supplying the decimal is highly recommended.

```
TEMPERATURE - SUITABILITY INDEX FILE FOR POUDRE RIVER. DATA FROM RALEIGH
BROWN     ADULT          AVG 0.0
     00.0  0.0
     32.0  0.0
     43.0  0.5
     54.0  1.0
     72.0  1.0
     75.0  0.0
     100.  0.0
**********
BROWN     JUVENILE       AVG 0.0
     00.0  0.0
     32.0  0.0
     43.0  1.0
     75.0  1.0
     79.0  0.0
     100.  0.0
**********
```

Miscellaneous Sample Data Files Included on the Sample Disk

AQBKWAT.DAT Annual streamflow file containing annual streamflow data for the Black River at Watertown, New York, that was used as input to the TRANTS program.

DQIN.DAT Free-formatted file containing daily streamflow values. This file can be used as input to the QIN program to create a daily streamflow file (ZDQ).

MQSANCK.DAT Monthly streamflow file containing the gaged streamflow data for Sandy Creek near Adams, New York, that was used as input to the TRANMR and TRANMN programs.

SVR30.DAT Monthly time series file containing reservoir storage volume data that was used as input to the RESYI program.

ZRESIN.DAT RESYLD input file created by the RESIN program.

Appendix B. Descriptions of Default Filenames

REELNO: File of tape reel numbers from the daily values backfile—generated by the GETREL program.

WATDUR: WATSTORE duration analysis file created by submitting the request file created by the DURTBL program to WATSTORE.

WATREQ: WATSTORE request file generated by the DAILY, DURTBL, INVENT, MESS, and PEAK programs.

WATMESS: WATSTORE message file.

ZANTS: Annual time series file; may contain habitat, streamflow, temperature, water quality, sediment, and other data.

ZDQ: Daily streamflow file in WATSTORE format.

ZHAQF: Habitat weighted usable area-versus-streamflow (habitat-versus-flow).

ZIN: Input file (various definitions).

ZMONQ: Monthly streamflow file in USGS or NWDC format.

ZMTS: Monthly time series file in USGS or NWDC format; may contain habitat, streamflow, temperature, water quality, sediment, and other data.

ZOUT: PROGRAM results.

ZREDUR: Reduced WATSTORE duration analysis file created by the SELDUR program.

Appendix C. Alphabetical Summary of TSLIB Batch–Procedure Files

The following table is divided into five columns. The first two columns list the program name and the batch filename (procedure filename on the CDC) used to execute it. The third column lists the function classification for the program. The fourth column gives a brief description of the function of the program, and the last column lists the batch–procedure name and shows the proper order of the files. The names of these files are the default filenames. Users may substitute their own filenames for these files. Note that on the micro, commas are not necessary; they are treated as blanks. Therefore, using the CDC convention of typing ", ," (two commas) to skip over a file will not work. Below the command line is a description of each file.

Output files are identified by "(output);" input files are identified by "(input)." Most of the default filenames begin with "Z" to avoid writing over any currently existing files. On the microcomputer this could happen easily, since there is no local file space, as on the CDC. Users should develop a convention of not starting their filenames with "Z". A list of the default filenames and their definitions can be found in Appendix B.

On the microcomputer there is a character graphics and a screen graphics version of each program that generates graphs (i.e., LPTDUR and LPTDURG). One batch file is used to run both versions; the user is prompted as to whether the graphs should go to the screen. If "yes" or "Y" is entered, the graphs will appear on the screen and a note stating that the graph was sent to the screen will be written to the output file in the position where the graph would have been had the character graphics version been run. If "no" or "N" is entered, graphs are written to the output file in a 132-character-per-line format.

To run the screen graphics versions of the plotting programs, the computer must have a color graphics adaptor (CGA) or compatible graphics card.

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
	INFODQ	Documentation	File format for free-formatted input file to QIN to create a daily streamflow file in WATSTORE format.	
	INFOMQ	Documentation	File format for free-formatted input file to QIN to create a monthly streamflow file in USGS format.	
	INFOTQ	Documentation	File format for free-formatted input file to HABNET to create a parameters file for a temperature vs. flow relationship.	
	INFOTSI	Documentation	File format for free-formatted input file to HABNET to create a temperature suitability criteria file.	
ANEQTS	**RANEQTS**	Annual Equivalent Adult Habitat Time Series Generation	Computes monthly and annual equivalent adult habitat time series for one species with up to five life stages.	**RANEQTS, ZHAQF, ZMONQ, ZOUT, ZMTS, ZANTS** **ZHAQF** = habitat vs. flow file for one species with up to five life stages; cannot be multirecord file (input) **ZMONQ** = monthly streamflow file in USGS or NWDC format; cannot be multirecord file (input) **ZOUT** = ANEQTS results, including tables and plots (output) **ZMTS** = monthly time series file containing equivalent adult habitat values (output) **ZANTS** = annual time series file containing composite, minimum, and maximum equivalent adult habitat values for each year (output)
ANNTS	**RANNTS**	Annual Time Series Generation	Creates an annual time series file from a set of monthly time series data. It also produces an output file containing tables and plots of the composite, minimum, and maximum annual time series values and a table showing duration data for the composite indices.	**RANNTS, ZMTS, ZOUT, ZANTS** **ZMTS** = monthly time series file in USGS or NWDC format; can be multirecord file. Usually output from HABTD or HABTS. (input) **ZOUT** = ANNTS results (output) **ZANTS** = annual time series file (output)
CEDUR	**RCEDUR**	Streamflow Data Listing	Analyzes a daily flow file and produces six different reports including daily, monthly, and yearly data summaries; flow exceedence percentages by month or by a user-defined time period; and percentage exceedence flows for user-defined percentages.	**RCEDUR, ZDQ, ZOUT** **ZDQ** = daily streamflow file in WATSTORE format (input). (This file must have been run through the DQFY program to remove incomplete years and extra title lines) **ZOUT** = data summaries, exceedence percentages, and percentage exceedence flows (output)
CHGFMT	**RCHGFMT**	Monthly Time Series Manipulation	Changes a USGS format file to a NWDC format file or vice versa.	**RCHGFMT, ZMTS, ZMTSN** **ZMTS** = monthly time series file in USGS or NWDC format, can be multirecord file (input) **ZMTSN** = new monthly time series file in NWDC or USGS format, will be multirecord if ZMTS is (output)
CHGMIN	**RCHGMIN**	ZRESIN File Modification	Changes the minimum flow values for the river at the dam, the pipe at the dam, and the river at the downstream control point.	**RCHGMIN, ZRESIN, ZRESINN** **ZRESIN** = RESYLD input file (input) **ZRESINN** = new RESYLD input file with modified minimum flow values (output)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
COMMTS	RCOMMTS	Monthly Time Series Manipulation	Sums two USGS formatted files month-by-month with given weights.	**RCOMMTS, ZMTS1, ZMTS2, ZMTSN** **ZMTS1** = monthly time series file in USGS format, can be multirecord (input) **ZMTS2** = monthly time series file in USGS format, can be multirecord (input) **ZMTSN** = combined monthly time series file in USGS format (output)
COMHQF	RCOMHQF	ZHAQF File Manipulation	Sums or combines habitat area data from two habitat area vs. streamflow files. Weighting factors are supplied by the user when files are combined. The weight for the first file must be less than or equal to "1". The weight for the second file is assumed to be "1" minus the first file weight. Any number of ZHAQF files may be combined by adjusting the weighting factors and running COMHQF on two ZHAQF files at a time.	**RCOMHQF, ZHAQFN, ZHAQF, ZHAQF2, ZOUT** **ZHAQFN** = summed or combined habitat area vs. streamflow file (output) **ZHAQF** = habitat area vs. streamflow file (input) **ZHAQF2** = habitat area vs. streamflow file (input) **ZOUT** = summed or combined habitat area in tables for each individual life stage (output)
CRHAQF	RCRHAQF	ZHAQF File Entry	Creates a habitat area versus streamflow file in the same format as created by the habitat simulation programs in PHABSIM. The program prompts for flows and weighted usable areas (WUA). An unlimited number of species, each with from 1–5 life stages, can be included.	**RCRHAQF, ZHAQF** **ZHAQF** = habitat vs. flow file (output)
DAILY	RDAILY	Streamflow Data Acquisition	Generates a "Mean Daily Streamflow Values" request file to retrieve data from the WATSTORE database.	**RDAILY, REELNO, WATREQ** **REELNO** = file of tape reel numbers from the Daily Values backfile (input). This file was created by the GETREL program. **WATREQ** = WATSTORE request file to obtain Mean Daily Streamflow Values (output)
DQDUR	RDQDUR	Daily Habitat Probability Exceedence Generation	Processes a WATSTORE duration analysis file with the following options: 0 = class distribution statistics 1 = habitat exceedence values and graphs, and class distribution statistics 2 = duration percentages 3 = all three.	**RDQDUR, WATDUR, ZOUT, ZHAQF, ZCLASS, ZEXPLT, ZMONTH, ZVAR, ZREDUR** **WATDUR** = WATSTORE duration analysis file. Can be directly from WATSTORE, or the reduced file created by the SELDUR program (input) **ZOUT** = file containing list of headings from the duration analysis file (output) **ZHAQF** = habitat vs. streamflow file. Only needed if Options 1 or 3 are selected (input). If not needed, enter ZZZ for this file. **ZCLASS** = class distribution statistics, created by Options 0, 1, and 3. (output) **ZEXPLT** = file containing exceedence plots, created by Options 1 and 3. (output) **ZMONTH** = file containing monthly exceedence statistics, created by Options 1 and 3. (output) **ZVAR** = file of percentage exceeded flows and variation ratios, created by Options 2 and 3. (output) **ZREDUR** = reduced WATSTORE duration analysis file. Created if WATDUR was directly from WATSTORE (output)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
DQFY	RDQFY	Streamflow Data Manipulation	Removes incomplete years from a daily streamflow file in WATSTORE format for use with the CEDUR, DQTOMQ and HABTD programs. DQFY also removes excess title lines (files from Hydrodata contain extra title lines).	**RDQFY, ZDQ, ZDQN** ZDQ = daily streamflow file in WATSTORE format (input) ZDQN = new daily streamflow file in WATSTORE format with complete years and two title lines (output)
DQTOMQ	RDQTOMQ	Streamflow Data Manipulation	Reads a daily streamflow file in WATSTORE format and writes a monthly streamflow file in NWDC format.	**RDQTOMQ, ZDQ, ZMONQ** ZDQ = daily streamflow file in WATSTORE format (input). This file must have been run through DQFY to remove incomplete years and excess title lines. ZMONQ = monthly streamflow file in NWDC format (output)
DURTBL	RDURTBL	Streamflow Data Acquisition	Generates a "Daily Streamflow Values Duration Table" request file to retrieve data from the WATSTORE database. The retrieved data can be used as input to the DQDUR program.	**RDURTBL, REELNO, WATREQ** REELNO = file of tape reel numbers from the Daily Values backfile (input). This file was created by the GETREL program. WATREQ = WATSTORE request file to obtain Daily Streamflow Values Duration Table (output)
EFFHAB	REFFHAB	Annual Effective Adult Habitat Time Series Generation	Calculates an effective adult habitat time series for four life stages of a given species.	**REFFHAB, EFHABIN, ZANTS,ZOUT** EFHABIN = EFFHAB input file created by the EFFIN program (input) ZANTS = annual time series file containing available and effective adult habitats (output) ZOUT = list of data and a table of equivalent adult habitats, available equivalent adult habitat used, beginning of the year adults, and the effective habitat time series (output)
EFFHB2	REFFHB2	Annual Effective Adult Habitat Time Series Generation	Calculates an effective adult habitat time series for four life stages with up to two age classes for fry and up to three age classes for juvenile.	**REFFHB2, EFHBIN2, ZANTS, ZOUT** EFHBIN2 = EFFHB2 input file created by the EFFIN2 program (input) ZANTS = annual time series file containing available and effective adult habitats (output) ZOUT = list of data and a table of equivalent adult habitats, available equivalent adult habitat used, beginning of the year adults, and the effective habitat time series (output)
EFFIN	REFFIN	Annual Effective Adult Habitat Time Series Generation	Creates an input file for the EFFHAB program from user input or from four annual habitat time series files.	**REFFIN, EFHABIN, ZANTS1, ZANTS2, ZANTS3, ZANTS4** EFHABIN = EFFHAB input file (output) ZANTS1 = annual habitat time series file for adults (input) ZANTS2 = annual habitat time series file for spawning (input) ZANTS3 = annual habitat time series file for fry (input) ZANTS4 = annual habitat time series file for juveniles (input) NOTE: **Input files must contain the same number of years of data and cannot be multirecord files.**

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
EFFIN2	**REFFIN2**	Annual Effective Adult Habitat Time Series Generation	Creates an input file for the EFFHB2 program from user input or from four or five annual habitat time series files.	**REFFIN2, EFHBIN2, ZANTS1, ZANTS2, ZANTS3, ZANTS4, ZANTS5** **EFHBIN2** = EFFHB2 input file (output) **ZANTS1** = annual habitat time series file for adults (input) **ZANTS2** = annual habitat time series file for spawning (input) **ZANTS3** = annual habitat time series file for fry (input) *If five input files are being used:* **ZANTS4** = annual habitat time series file for second fry age class (input) **ZANTS5** = annual habitat time series file for juveniles (input) *If four input files are being used:* **ZANTS4** = annual habitat time series file for juveniles (input) **NOTE: Input files must contain the same number of years of data and cannot be multirecord files.**
GET1	**RGET1**	Time Series Manipulation	Extracts records from a multirecord file.	**RGET1, ZIN, ZOUT** **ZIN** = multirecord file (input) **ZOUT** = file with selected records (output)
GETREL	**RGETREL**	Streamflow Data Acquisition	Processes the WATSTORE message file (obtained by submitting the file created by the MESS program) and generates a file of tape reel numbers from the Daily Values backfile. This file is used by the DAILY, DURTBL, and INVENT programs when generating a request job from WATSTORE.	**RGETREL, WATMESS, REELNO** **WATMESS** = WATSTORE message file (input) **REELNO** = file of tape reel numbers from the Daily Values backfile (output)
HABINN	**RHABINN**	HABNET Options File Creation	Builds a HABNET options file.	**RHABINN, ZHABIN** **ZHABIN** = HABNET options file (output)
HABNET	**RHABNET**	Network-Wide Monthly Habitat Time Series Generation	Generates a network-wide monthly habitat time series. Habitat values may be temperature conditioned at the option of the user.	**RHABNET, ZHABIN, ZMTS, ZMTSM, ZHAQFM, ZTEMP, ZTSI, ZOUT** **ZHABIN** = HABNET input file created by the HABINN program (input) **ZMTS** = habitat time series data (output). Will be in the same format as ZMTSM. **ZMTSM** = modified monthly flow time series in USGS or NWDC format (input). Can be a multirecord file. **ZHAQFM** = modified habitat area vs. streamflow file with month indicators and minimum habitat values (input). This file can be created by the HQFMON program. **ZTEMP** = temperature time series data in USGS or NWDC format *or* a free-formatted file with parameters for a temperature vs. flow relation (optional input). The free-formatted file can be created with the QTEM program or type INFOTQ for information on the format of the free-formatted file. **ZTSI** = network temperature suitability criteria file *or* FISHCRV file with temperature suitability criteria (optional input). Type INFOTSI for information on the format of the network temperature suitability criteria file. **ZOUT** = HABNET results (output)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
HABOUT	**RHABOUT**	ZHAQF File Listing	Arranges a habitat area vs. streamflow file by month and determines the total area per 1000 feet of stream water for each flow, with an option to compute a yearly average for each flow. HABOUT also computes the adult equivalent habitat for each species.	**RHABOUT, ZHAQFM, ZOUT, ZHAQFN** **ZHAQFM** = habitat vs. flow file for 12 months (input). Same format as ZHAQF file except only 12 values are entered, one per month. If more than 12 values are in the input file, only the first 12 are read. **ZOUT** = HABOUT results (output) **ZHAQFN** = habitat vs. flow file with adult equivalent habitat values (output)
HBOUTA	**RHBOUTA**	ZHAQF File Listing	Writes the data from a habitat area vs. streamflow file into a format that may be useful for report purposes.	**RHBOUTA, ZHAQF, ZOUT** **ZHAQF** = habitat vs. flow file (input) **ZOUT** = HBOUTA results (output)
HABTD	**RHABTD**	Daily Habitat Time Series Generation	Calculates the time series of daily habitat values and converts these to monthly habitat time series using user-supplied criteria.	**RHABTD, ZHAQF, ZDQ, ZMTS, ZOUT, DAYFL** **ZHAQF** = habitat vs. flow file (input) **ZDQ** = daily streamflow file in WATSTORE format (must have been run through DQFY to strip incomplete years and excess title lines (input) **ZMTS** = monthly habitat time series file in NWDC format, one logical record per life stage (output) **ZOUT** = HABTD results (output) **DAYFL** = file of daily habitat values in either report or Lotus 1-2-3 format. Created when daily habitat values are requested (output)
HABTS	**RHABTS**	Monthly Habitat Time Series Generation	Creates a monthly physical habitat time series file for multiple species and life stages. The program calculates monthly habitat values at the site, using linear or non-linear interpolation, for each species/life stage.	**RHABTS, ZHAQF, ZMONQ, ZMTS, ZOUT** **ZHAQF** = habitat vs. flow file (input) **ZMONQ** = monthly streamflow file in USGS or NWDC format (input) **ZMTS** = monthly habitat time series file with multiple records in the same format as the ZMONQ file (output) **ZOUT** = HABTS results (output)
HAQINT	**RHAQINT**	ZHAQF File Manipulation	Uses a given habitat versus streamflow file to estimate habitat for different flows by interpolation.	**RHAQINT, ZHAQFN, ZHAQF** **ZHAQFN** = habitat vs. flow file for requested flows (output) **ZHAQF** = habitat vs. flow file (input)
HQFMON	**RHQFMON**	HABNET ZHAQFM File Creation	Adds month indicators and minimum habitat values to a habitat area versus streamflow file.	**RHQFMON, ZHAQF, ZHAQFM** **ZHAQF** = habitat area vs. streamflow file (input) **ZHAQFM** = habitat area vs. streamflow file with month indicators and minimum habitat values (output). An extra title line and segment ID line can also be added if they were not previously entered with an editor.
INVENT	**RINVENT**	Streamflow Data Acquisition	Generates a station inventory request file to "Inventory Daily Values Data" from the WATSTORE database.	**RINVENT, REELNO, WATREQ** **REELNO** = file of tape reel numbers from the Daily Values backfile (input). This file was created by the GETREL program. **WATREQ** = WATSTORE request file to obtain an inventory of Daily Values Data (output)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
LPTDAN	RLPTDAN	Analyzing and Displaying Annual Time Series Data	Reads one or two annual time series files and writes an output file containing an annual duration table showing ordered annual data, a summary statistics table containing average, median, index-A, index-B, index-C, 10%, 20%, 80%, and 90% exceedence, and an exceedence plot.	**RLPTDAN, ZOUT, ZANTS, ZANTS2** **ZOUT** = LPTDAN results (output) **ZANTS** = annual time series file (input) **ZANTS2** = second annual time series file (input) **NOTE: Input files do not have to contain the same number of years. Multirecord files may be used.**
LPTDUR	RLPTDUR	Analysis of Monthly Time Series Data	Reads one or two monthly time series files and creates an output file arranged either by groups of months or by individual months containing annual duration tables showing ordered monthly data for each month or group of months, an exceedence plot for each month, a summary statistics table showing average, median, index-A, index-B, index-C, 10%, 20%, 80%, 90% exceedence, and plots showing median, average, change in median, and change in average for the two data sets.	**RLPTDUR, ZOUT, ZMTS, ZMTS2** **ZOUT** = LPTDUR results (output) **ZMTS** = monthly time series file in USGS or NWDC format (input) **ZMTS2** = second monthly time series file in USGS or NWDC format (input). **NOTE: Input files do not have to be in the same format or contain the same number of years; however they must begin with the same month. Input files may be multirecord.**
LPTHQF	RLPTHQF	ZHAQF File Display	Plots the habitat vs. flow functions—one species per page; 1–5 life stages.	**RLPTHQF, ZHAQF, ZOUT** **ZHAQF** = habitat vs. flow file (input) **ZOUT** = LPTHQF results (output)
LPTQHA	RLPTQHA	Displaying Monthly Time Series Data	Plots monthly habitat area or streamflow from one or two monthly time series files, approximately five years per page. Program has the option to plot the Y-axis using either a logarithmic or linear scale. If the minimum data value is less than the maximum data value divided by 50.0, then the Y-axis is logarithmic.	**RLPTQHA, ZOUT, ZMTS, ZMTS2** **ZOUT** = LPTQHA results (output) **ZMTS** = monthly time series file in USGS or NWDC format (input) **ZMTS2** = second monthly time series file in USGS or NWDC format (input). **NOTE: Input files do not have to be in the same format or contain the same number of years; however they must begin with the same month. Multirecord files may be used.**
LPTTSN	RLPTTSN	Displaying Monthly Time Series Data	Reads up to five monthly time series files in USGS or NWDC format and plots the data in a user-specified range of years. Output includes tables and plots.	**RLPTTSN, ZOUT, ZMTS1, ZMTS2, ZMTS3, ZMTS4, ZMTS5** **ZOUT** = LPTTSN results (output) **ZMTS(1–5)** = monthly time series files in USGS or NWDC format (input). **NOTE: Input files do not have to be in the same format or contain the same number of years; however they must begin with the same month. Multirecord files cannot be used.**
LSTDQ	RLSTDQ	Streamflow Data Listing	Writes a file containing header information and title lines or information by water years in a daily streamflow file. WATSTORE files may contain several data sets with individual title lines.	**RLSTDQ, ZDQ, ZOUT** **ZDQ** = daily streamflow file in WATSTORE format (input) **ZOUT** = LSTDQ results (output). If filename is not specified and only headers are requested, output will go to the screen.
MESS	RMESS	Streamflow Data Acquisition	Generates a "WATSTORE message" request file to retrieve data from the WATSTORE database for use with the GETREL program.	**RMESS, WATREQ** **WATREQ** = request file to obtain WATSTORE message file (output)
MRGHQF	RMRGHQF	ZHAQF File Manipulation	Extracts up to five life stages from one or two habitat versus streamflow files and creates a new habitat versus streamflow file.	**RMRGHQF, ZHAQFN, ZHAQF, ZHAQF2** **ZHAQFN** = habitat vs. streamflow file with selected life stages (output) **ZHAQF** = habitat vs. streamflow file (input) **ZHAQF2** = habitat vs. streamflow file (input)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
MTSLST	RMTSLST	Displaying Monthly Time Series Data	Produces a formatted table of monthly time series values and their averages. These tables are useful for exporting to Lotus 1-2-3 or other application programs.	RMTSLST, ZMTS, OUTMON, OUTAVG ZMTS = monthly time series file, can be multi-record (input) OUTMON = table of time series data listed monthly for each year (output) OUTAVG = table of average monthly and coefficient of variation values (output)
MULHQF	RMULHQF	ZHAQF File Manipulation	Weights individual life stages, or multiplies/divides habitat values in a habitat versus streamflow file by a constant.	RMULHQF, ZHAQFN, ZHAQF ZHAQFN = habitat vs. streamflow file with adjusted habitat values (output) ZHAQF = habitat vs. streamflow file (input)
MULMTS	RMULMTS	Monthly Time Series Manipulation	Multiplies all the data in a monthly time series file in USGS or NWDC format by a constant. The output file is in the same format as the input file.	RMULMTS, ZMTS, ZMTSN ZMTS = monthly time series file; can be multi-record file (input) ZMTSN = new monthly time series file after multiplication (output)
NRMHQF	RNRMHQF	ZHAQF File Manipulation	Normalizes habitat values in a habitat versus streamflow file with respect to a given discharge and the corresponding area. If the given discharge is not on the file, it will be added and the habitat values will be calculated by interpolation for the discharge. If the first record in the input file is not area, the user will be prompted to enter the area.	RNRMHQF, ZHAQFN, ZHAQF ZHAQFN = normalized habitat vs. streamflow file (output) ZHAQF = habitat vs. streamflow file (input)
PAGEBR	RPAGEBR	Streamflow Data Manipulation	Prepares a WATSTORE output file (generated using the request file created by the DAILY, DURTBL, INVENT, or PEAK programs) for printing. PAGEBR inserts a printer control character at points where printing should begin on a new page.	RPAGEBR, ZIN, ZOUT ZIN = WATSTORE output file (input) ZOUT = WATSTORE output file with page breaks (output)
PEAK	RPEAK	Streamflow Data Acquisition	Generates a "Peak Streamflow Values" request file to retrieve data from the WATSTORE database.	RPEAK, WATREQ WATREQ = WATSTORE request file to obtain Peak Streamflow Values (output)
QABSDY	RQABSDY	Water Resource Systems Analysis	Subtracts a diversion flow by day from a daily streamflow file, while leaving a user-specified minimum flow in the main stream.	RQABSDY, ZDQ, ZDQD, ZDQR, ZOUT ZDQ = daily streamflow file in WATSTORE format, or a free-formatted file with streamflows and dates (input) ZDQD = diversion streamflows in daily flow file format, or a free-formatted file with diversion flows and dates (input) ZDQR = required minimum instream streamflows in daily flow file format, or a free-formatted file with required instream flows and dates (input) ZDQN = daily streamflow file with flows left after the diversion (output) ZOUT = QABSDY results, including annual shortages and diversions (output)
QABSMN	RQABSMN	Water Resource System Analysis	Subtracts a diversion flow by month from a monthly streamflow file, while leaving a user-specified minimum flow in the main stream.	RQABSMN, ZMONQ, ZMONQN, ZOUT ZMONQ = monthly streamflow file in USGS or NWDC format (input) ZMONQN = monthly streamflow file in the same format as the ZMONQ input file, with diversion flows subtracted from the monthly flows (output) ZOUT = QABSMN results, including annual shortages and diversions (output)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
QIN	RQIN	Streamflow Data Entry	Creates a streamflow data file in WATSTORE or USGS format from keyboard entry or from a free-formatted ASCII file created with an editor. Type INFODQ or INFOMQ for information on the format of the free-formatted input file for daily or monthly streamflow.	**RQIN, ZQFIL, ZQIN** **ZQFIL** = daily streamflow file in WATSTORE format *or* monthly streamflow file in USGS format (output) **ZQIN** = free-formatted ASCII text file containing responses to program prompts. If no filename is entered, keyboard input is assumed (input)
QTEM	RQTEM	HABNET ZTEMP File Creation	Generates a temperature vs. flow equation file.	**RQTEM, ZTEMP** **ZTEMP** = free-formatted flow vs. temperature equation file (output)
RESIN	RRESIN	RESYLD Input File Creation	Creates an input file for the RESYLD program with the flows from one or two monthly streamflow files or from user input.	**RRESIN, ZRESIN, ZMONQ, ZMONQ2** **ZRESIN** = RESYLD input file (output) **ZMONQ** = monthly streamflow file in USGS or NWDC format (optional input). Reservoir inflows will be calculated from this flow file. The local inflows can also be calculated from this file or entered manually. **ZMONQ2** = monthly streamflow file in USGS or NWDC format (optional input) Local inflows will be calculated from this flow file if two flow files are used as input.
RESYI	RRESYI	Reservoir Yield Index Computation	Computes the yield index for a reservoir given a RESYLD input file and a monthly time series file with reservoir surface area or storage volume values.	**RRESYI, ZRESIN, ZMTS, ZMTSN, ZANTS, ZOUT** **ZRESIN** = RESYLD input file (input) **ZMTS** = monthly time series file containing reservoir surface areas or storage volumes (input) **ZMTSN** = Monthly time series file containing reservoir yield index values (output) **ZANTS** = annual time series file containing reservoir yield index values (output) **ZOUT** = RESYI results including area, storage volume, and yield index (output)
RESYLD	RRESYLD	Water Resource Systems Analysis	Operates a single reservoir with monthly flows using criteria such as the maximum and minimum flow at the reservoir and downstream, downstream water rights, pipe flow from the reservoir, and power production.	**RRESYLD, ZRESIN, ZRES, ZOUT** **ZRESIN** = RESYLD input file created by the RESIN program (input) **ZRES** = RESYLD output file containing pipe and river flows from the reservoir, river flow downstream, reservoir storage, inflow, elevation, evaporation, surface area, unregulated flow downstream, downstream water rights, and power production (output) **ZOUT** = RESYLD results (output)
RSTOMQ	RRSTOMQ	RESYLD Output File	Converts the output file (ZRES) from the RESYLD program to a multirecord monthly flow file.	**RRSTOMQ, ZRES, ZMONQ** **ZRES** = RESYLD input file (input) **ZMONQ** = monthly flow file in USGS or NWDC format (output)
SCORTS	RSCORTS	Analysis of Monthly Time Series Data	Reads a monthly time series file and calculates several statistical parameters, including log normal distribution, and lag one correlation coefficients.	**RSCORTS, ZMTS, ZOUT, ZANTS** **ZMTS** = monthly time series file in USGS or NWDC format; can be multirecord (input) **ZOUT** = SCORTS results (output) **ZANTS** = average of 12 monthly values for each year (output)

PROGRAM NAME	BATCH/ PROCEDURE FILENAME	FUNCTION	DESCRIPTION OF FUNCTION	DESCRIPTION OF INPUT/OUTPUT FILES
SELDUR	RSELDUR	Streamflow Data Manipulation	Takes a WATSTORE duration analysis file (created by submitting the request file created by DURTBL to WATSTORE) and creates a smaller file with the same information which can be used as input to the DQDUR program.	**RSELDUR, WATDUR, ZREDUR** **WATDUR** = WATSTORE duration analysis file (input) **ZREDUR** = reduced WATSTORE duration analysis file (output)
SELMTS	RSELMTS	Monthly Time Series Manipulation	Allows selection of individual months or groups of months from two or more monthly time series data files to create a single, composite monthly time series file.	**RSELMTS, ZMTSN, ZMTS** **ZMTSN** = new monthly time series file in the same format as the input files (output) **ZMTS** = a base monthly time series file to be used as a building block; can be multi-record (input). User will be prompted to enter filenames for other ZMTS files to select months from. **NOTE: All input files must be in the same format (USGS or NWDC), contain the same number of years, and begin with the same month.**
SUMHQF	RSUMHQF	ZHAQF File Manipulation	Sums conditional cover columns in a ZHAQF file into one habitat versus flow figure for each life stage. Run when conditional cover curves were used as input to the habitat simulation programs. Allows up to five life stages to be grouped in each record.	**RSUMHQF, ZHAQF, ZHAQFN** **ZHAQF** = habitat vs. streamflow file (input) **ZHAQFN** = modified ZHAQF file with columns summed (output)
TRANTS	RTRANTS	Transferring Streamflow Data	Transfers an annual streamflow file from a long record site to a short record site using the equation: Qnew = A*(Qold)**B.	**RTRANTS, ZANTS, ZANTSN** **ZANTS** = annual time series file containing streamflow data from a long record site (input) **ZANTSN** = transferred annual time series file for a short record site (output)
TRANMN	RTRANMN	Transferring Streamflow Data	Transfers a monthly streamflow file from a gaged site to an ungaged site using the equation: Qnew = A*(Qold)**B with options to use different A and B values for different flow ranges, or to compute A and B using given old and new flows.	**RTRANMN, ZMONQ, ZMONQN, ZOUT** **ZMONQ** = monthly streamflow file (in USGS or NWDC format) for a gaged site (input) **ZMONQN** = monthly streamflow file with calculated flows for the ungaged site (output) **ZOUT** = TRANMN results (output)
TRANMR	RTRANMR	Transferring Streamflow Data	Transfers a monthly streamflow file for a gaged (measured) site to an ungaged site using one of the following methods: (1) drainage area ratio; (2) drainage area and precipitation ratio; or (3) regional statistics method.	**RTRANMR, ZMONQ, ZMONQN, ZOUT** **ZMONQ** = monthly streamflow file (in USGS or NWDC format) for a gaged site (input) **ZMONQN** = monthly streamflow file with calculated flows for the ungaged site (output) **ZOUT** = TRANMR results (output)

Appendix D. Installing and Running PHABSIM and TSLIB on a Microcomputer

Hardware and Software Requirements

To run the PHABSIM or TSLIB programs on a microcomputer, the following hardware–software is *required*:

1. IBM-compatible microcomputer—AT or better recommended,
2. 640K of available RAM memory,[a]
3. At least one floppy disk drive,
4. MS-DOS (PC-DOS) version 3.00 or later, and
5. An editor with ASCII file compatibility.

The following are highly recommended but not required:

1. A mass storage device (i.e., a hard disk or a Bernoulli box) with at least 10K of memory (20K would be better),
2. An 8087 or compatible numeric coprocessor—if it is present, the software will use it; if it is not available, it will be emulated. The benefits of time savings from the use of such a coprocessor may be illustrated by run times of one of the programs:

	With 8087	Without
PC (8088) Architecture	12 s	263 s
AT (80286) Architecture	4 s	75 s,

3. A monitor with 640 × 200 graphics. To run screen graphics versions of the programs, your computer must have a color graphics adaptor (CGA) or compatible graphics card, and
4. A printer with graphics capability and with ability to print 132 characters per line.

Making Copies of the PHABSIM or TSLIB Diskettes

This write-up assumes a minimal working knowledge of MS-DOS. It is left to the user to decide how to arrange MS-DOS directories, subdirectories, and paths to control proper program flow with the desired data files. It may be desirable to have all executable programs, batch files, and the error message library (RMFORT.ERR) in one directory and have data files in other directories.

We have chosen the following conventions for naming files:

[program name].EXE—Executable program file
R[program name].BAT—Batch file for controlling execution of a program
[filename].DOC—Documentation

[a] Not all of the programs require 640K RAM memory.

1. Load DOS on your system.
   Whether you start your system from a floppy or hard disk, proceed until you have a DOS prompt on the screen.
2. Write-protect your distribution diskettes.
   Use a write-protect sticker (or opaque tape) to cover the small cutout area of the diskette.
3. If you are using floppy disks, make working copies of the distribution diskettes using the DISKCOPY command as follows:

A:\>DISKCOPY A: B:

Answer the diskcopy prompts that appear. If asked, the source diskette refers to the distribution diskettes being copied. The target diskette is the diskette that will become the working copy. Label your working copies with a felt-tipped marker.

If you are using a hard disk drive, create a subdirectory and make that your working directory:

C:\>MKDIR [directory name]

C:\>CD [directory name]

One at a time, copy the PHABSIM–TSLIB distribution diskettes to this directory by placing the source diskette into drive A and enter the following command.

C:\>COPY A:*.*

Note: If your hard disk does not contain enough space to hold all programs at once, you may want to put on just the category of programs with which you are working at the time (i.e, daily time series, monthly time series, etc.).

4. Put the write-protected PHABSIM–TSLIB distribution diskettes in a safe place.

Distribution

There are no restrictions on the distribution of the PHABSIM–TSLIB programs. We ask only that any copies you make for others be exact duplicates of the original diskettes so that each set consists of unmodified files.

The Preface of this manual and the file MOU.TXT contain a copy of our software distribution policy. Please refer to them for more information.

We prefer not to distribute the source code for these programs unless the need dictates. However, the source code is available. PHABSIM–TSLIB programs are written in Ryan-McFarland FORTRAN 77. Batch files are written in MicroSoft's batch language.

Configuring Your System

Before running PHABSIM–TSLIB, you must first modify or create a CONFIG.SYS file to enable MS-DOS to allocate enough room for the data files used by the programs. Specifically, the CONFIG.SYS file must include the following statements:

```
FILES-20
BUFFERS-20
SHELL-X:\COMMAND.COM /E:xxx /P
 (where X = drive where system commands are stored,
   xxx = bytes to reserve for the environment block.)
```

For DOS Version 3.2, set xxx to 512.
For DOS Version 3.0–3.1, set xxx to 32.

The SHELL= statement relates to environment space. The DOS default environment space is 160 characters. This statement allows you to increase the environment space.

The AUTOEXEC.BAT file should also be modified or created to contain the following statements:

```
GRAPHICS (or whatever graphics printer driver you have)
PATH drive:\[directory name]
SET  \RMFORT.ERR=\[directory name]\RMFORT.ERR
```

In the path statement, the directory name should be the directory where the PHABSIM–TSLIB programs are located. In the set statement, the directory name should be the directory where the RMFORT.ERR file is located on your system. RMFORT.ERR is the Ryan-McFarland FORTRAN 77 error message file.

Similarities and Differences with Mainframe PHABSIM–TSLIB

1. Since XEDIT is not available for micros, we have assumed that all users will have their own editor (or word processor) for simple editing tasks. We can supply a shareware screen editor, WED, if needed.

2. The FORTRAN line printer carriage control convention of using a "1" in column 1 to go to the top of the next page has been replaced with the more standard (but not completely standard) control-L or form-feed character. Most micro printers will behave appropriately. If for some reason your printer does not perform as expected, you could use your editor to globally replace all control-L's with whatever you need.

3. Similarly, many program output files are written for wide carriage (132 column) output capability. Most narrow carriage printers will emulate a wide carriage by sending a special control (escape) sequence or by pressing certain buttons on the printer. Most typically this sends the printer into a 17-characters-per-inch mode to fit 132 columns into a smaller area. Our programs will not control this feature. It is your responsibility. We can supply utility programs for most Epson- or Hewlett-Packard-compatible printers. Ask us about SETUP. Also, we have the LIST utility that is good for looking at 132-column output on your 80-column screen.

4. The microcomputer version of the PHABSIM–TSLIB programs differ from their Cyber counterparts in that they do not have a "?" prompt.

5. Mainframe computers have different ways of prematurely halting program operation. Typing STOP, %2, <CR>, and Control-T have all been replaced on the microcomputer by typing Ctrl-Break.

6. Because the number of significant digits maintained by a microcomputer and by a CDC mainframe differ, it is inevitable that calculations that involve very small numbers may produce slightly different results. This difference may cause single points on a graph to be one plot position different. However, this does not affect the usefulness of the graphs generated on a microcomputer.

7. Unformatted files such as TAPE3, TAPE4, TP4, FISHFIL, and ZHCF (in PHABSIM) are likely to be incompatible between a microcomputer and the CDC mainframe and between different microcomputers. The formatted version of the files should be used when transferring from computer to computer.

8. On the microcomputer, there is a character graphics and a screen graphics version of each program that generates graphs (i.e., LPTDUR and LPTDURG). One batch file is used to run both versions; the user is prompted as to whether the graphs should go to the screen. If "Yes" is entered, the graphs will appear on the screen and notes will be written to the output file in the positions where the graphs would have been written if the character graphics version had been run. If "No" is entered, graphs are written to the output file in a 132-characters-per-line format.

To run the screen graphics version of the plotting programs, the computer must have a color graphics adaptor (CGA) or compatible graphics card.

Graphics for the Hewlett-Packard Laser Jet Printer

To set the character size for character-based graphs using an HP Laser Jet Printer, the font must be changed by a series of printer commands. Printing the commands will cause the printer to read the commands and change fonts. The commands are described in Chapter 3 of the Laserjet Printer User's Manual.

To set the printer for one graph per page, the character size must be changed by the command

<ESC>(s16.66H

where <ESC> = the escape key. This command sets the printer for 128 characters per line.

The printer may also be set to increase the number of lines per inch, so that comments may be printed above or below the graph, or more than one graph may be printed on a page.

To set the number of lines per inch, the command is

<ESC>&l#D

where # = the number of lines per inch. The value for # may be 1, 2, 3, 6, 8, 12, 16, 24, or 48.

= 8 is recommended for comments above or below the graph,

= 12 will print 2 graphs per page, but lines may be hard to read.

To set the printer back to the original font the command is

<ESC>E

Some editors may not recognize the escape key, and many editors will show different characters for the escape key. The WED editor uses a left arrow to show the escape key.

It is recommended that frequently used font commands be written to a file so the file can be sent to the printer each time the font needs to be changed. The printer will output a blank page when the file of commands is printed. Another file should be created with the escape E (<ESC>E) command to set the printer back to default fonts. To change the font while printing the output file, the commands may be added directly to the output file. Adding the commands to the output will allow printing of reduced-size graphs and normal-size text on the same page. Remember to set the printer back to the default fonts before printing other documents.

Running PHABSIM–TSLIB Using Batch Files

Batch files contain sets of several system commands arranged to perform a specific task. To run a batch file, type the batch filename and then the appropriate input and output filenames, separated with a space or a comma. The batch filename is usually the program name preceded by "R".

Typing just the batch filename gives information on the function of the program and (or) batch file, substitution order, default input and output filenames, and the description of what the input and output files contain. Appendix C contains an alphabetical listing of all the batch files with this information.

Example: RHABTD

Program HABTD determines the time series of daily habitat values and converts these to monthly time series habitat data from user-supplied criteria.

RHABTD, ZHAQF, ZDQ, ZMTS, ZOUT, DAYFL

where

ZHAQF = Habitat area-versus-streamflow file (input).
ZDQ = Daily streamflow file in WATSTORE format (input). This file must have been run through DQFY to strip incomplete years and excess title lines.
ZMTS = Monthly habitat time series file in NWDC format, one logical record per life stage (output).
ZOUT = HABTD results (output).
DAYFL = File of daily habitat values in either report or LOTUS 1-2-3 format. Created when daily habitat values are requested (output).

Notes on Entering Data

The following data entry alternatives can be used when prompted to enter a list of numbers or coordinate pairs: (1) Each number may be entered on a separate line, (2) a comma or one or more spaces may be used as the delimiter, or (3) a combination of commas and spaces may be used. Examples of monthly streamflow values entered in the QIN program follow.

- Entered on a separate line

523—1st month
479—2nd month
715—3rd month
865—4th month
.....

- Separated by commas

  523, 479, 715, 854, ...

- Separated by spaces

  523 479 715 854 . . . . .

Runtime Error Messages

When an error occurs you should get a message like the following:

Error at line ### in program name Error number ####
(the error message)

If you only get numbers, make sure the command, as described in the "Configuring your system—AUTOEXEC.BAT section—SET RMFORT.ERR = \ [directory name]\RMFORT.ERR" is set to the directory containing RMFORT.ERR.

The following is a list of common errors that could occur when running the programs. Also included are explanations and suggested remedies to the situations.

-1 READ PAST END OF FILE: An attempt was made to read past the end of a file. Check the input file.

2015 OPEN STATUS is OLD but file does not exist: The input file specified does not exist. Check path and spelling.

2514 Incorrect integer input: A character or real number was read for integer input. This can occur either in response to a prompt or when an input file has the wrong format.

2517 Incorrect integer character: A character was read for numeric input.

2519 Incorrect exponent in input: A character was read for numeric input. It is common that your input file mistakenly has an l ("el") instead of a 1 ("one"), or an O ("oh") instead of a 0 ("zero").

3012 File opening failure: This error usually indicates that a file cannot be found in the current directory or on the directory specified when entering the filename (i.e., d:\ data \ i4data).

3023 End of file before new line on reading formatted sequential record: Read an end-of-file marker from input file when it was expecting more input. Check format of input file. If you are using the WED editor, the file must have a carriage return as the last line to properly mark end of file.

3033 Write error on formatted sequential record: Check to see if disk is full. Delete some files or try running on the hard disk.

3087 Read error on formatted sequential record: Check the format of your input file.

4002 Incorrect DOS version: Your version of DOS is earlier than 3.00. Replace it with DOS 3.00 or later version.

Out of environment space: The DOS environment memory limitation has been exceeded. See section "Configuring Your System" (Appendix D) to see that you have environment space set according to the version of DOS you are using. If so, shorten your PATHs and any other unnecessary SETs. The environment is set by your AUTOEXEC.BAT file each time you boot-up the system. To look at this environment, type SET carriage return. To shorten PATHs, retype the path line with only paths needed to run PHABSIM–TSLIB programs followed by a carriage return. To remove SETs, type SET name=carriage return.

If you are having trouble running a PHABSIM–TSLIB program, try changing ECHO OFF at the beginning of the associated batch file to ECHO ON. This will allow you to follow the (rather complex) series of commands, and possibly help you to discover your (or our) mistake. A "Ctrl S" will stop scrolling on the screen so that you can see what is happening; "Ctrl Q" will start scrolling again.

Appendix E. Running PHABSIM and TSLIB on a CDC Cyber Computer

The Physical Habitat Simulation System (PHABSIM) and the Time Series Library (TSLIB) programs are currently maintained on the following Control Data Corporation (CDC) Cyber mainframe. For information, contact

U.S. Bureau of Reclamation
Division of Data Processing
User Support Branch
P.O. Box 25007, DFC
Denver, CO 80225

(303) 236-9334 or FTS 776-9334

The USBR computer system is limited to use by Government agencies and does not solicit commercial accounts.

Logging On to the USBR Cyber Computer

Turn on your terminal and modem and dial the computer (USBR—303,236-4601, or FTS—776-4601). At the sound of the high-pitched tone, place the telephone in the modem. The carrier light should go on. If it is not lit, then a connection to the host computer was not made. Hang up, redial, and try again.

When the carrier light is lit and CONNECT appears on the screen, press the return key at least twice. The computer will then display information regarding the system to which you have connected.

- A carriage return follows each line of information you enter.
- Guard your password, as it is the only protection you have for your account. That is why the computer automatically overstrikes the area in which you type it.
- Write down your JSN in case it is needed later to recover. In the following examples, the JSN is XXXX,YYY.

```
WELCOME TO THE B.O.R. NETWORK P/S:C
SYSTEMS PRESENTLY AVAILABLE ARE:

**SYSTEM**                 **NAME**

CYBERS (AA OR EE)          CYB
VAX 8300'S                 8300
VAX-IDS                    IDS

TO SELECT A SYSTEM, ENTER THE SYSTEM
NAME AND CARRIAGE RETURN AT NEXT
PROMPT.

CHANNEL 02/126. ENTER RESOURCE
```

You would enter CYB here and then press the carriage return a few times.

```
CONNECTED TO 04/063

NO HOST SELECTED      CONTROL CHARACTER=(ESC)
NPU NODE= 6 TERMINAL NAME= T12K22
HOST   NODE  SELECTED/        STATUS
CONNECTED
AA      16                    AVAILABLE
EE      17                    AVAILABLE
ENTER (ESC)HN=NODE NUMBER OR
(ESC)HS=NAME TO SELECT HOST
```

Press ESC, type HS=EE and then press the carriage return a few times.

```
HOST   NODE  SELECTED/        STATUS
CONNECTED
AA      16                    AVAILABLE
EE      17       S            AVAILABLE
ENTER INPUT TO CONNECT TO HOST
```

Press the carriage return a few times.

```
WELCOME TO THE NOS SOFTWARE SYSTEM.
COPYRIGHT CONTROL DATA, 1978, 1987.
88/01/26. 10.52.05. T12K22
CYBER 170/ 875  EE NOS 2.5 PRODUCTION.  USBR - V71122.

USER NAME:          [Enter your account user name]
PASSWORD:           [Enter your account password]
```

With a proper log-in, the computer will respond:

```
YOUR PASSWORD WILL BE EXPIRED [year, month, and date]

JSN: XXXX,YYY
TID:                [Enter your terminal ID #]
LAST MOTD REVISION DATE - 01-26-88.  0830 HOURS
DO YOU WANT TO SEE THE MESSAGE OF THE DAY?  (Y OR N)
?
READY
```

Type in BAT to move you into the batch subsystem.

```
$RFL,0.
/
```

When the prompt "/" is on the screen, you have successfully logged on to the USBR Cyber computer.

Running PHABSIM–TSLIB and Using Procedure Files

After logging on to the computer, the user must transfer the following files into his local file space. It is not recommended that they be stored as permanent files, as the user would then have to pay storage costs and may not have current versions of programs or procedures.

USBR–PHABSIM

```
/GET,PHABPRC/UN=FW24022
/LIBRARY,PHABPRC
```

USBR–TSLIB

```
/GET,TSPROC/UN=FW24022
/LIBRARY,TSPROC
```

PHABPRC and TSPROC contain the procedure files that have been developed to assist the user in running the PHABSIM and TSLIB programs. Procedure files contain sets of several system commands arranged to perform a specific task.

To run a procedure, type the procedure name and then the appropriate input and output file names, separated by a comma. The procedure name is usually the program name preceeded with R.

Example: RIFG4, ZIFG4, ZOUT, TAPE3, TAPE4, TP4, ZVAFF, ZVCEF

On the Cyber, a " , " (comma) may be entered if the default filename is being used.

Example: RIFG4, I4DATA, IFG4OUT, , , ZVAFF1

Typing just the procedure name gives information on the function of the program or procedure, substitution order, default input and output filenames, and description of what the input and output files contain. Appendix C contains an alphabetical listing of all the procedures with this information.

Example: RIFG4

Program IFG4 uses a stage–discharge relation to determine water surface elevations unless they are supplied in the data set. When using the stage–discharge relation, each cross section is treated independently of all others in the data set. The velocities are determined using techniques based on Manning's Equation.

RIFG4, ZIFG4, ZOUT, TAPE3, TAPE4, TP4, ZVAFF, ZVCEF

where

ZIFG4 = IFG4 data set (input),
ZOUT = IFG4 results (output),
TAPE3 = unformatted cross section and reach data (output),
TAPE4 = unformated flow data (output),
TP4 = rearranged TAPE4 file of unformatted flow data (output),
ZVAFF = velocity adjustment factor file; created if IOC(13) = 1 (output), and
ZVCEF = velocity calibration errors file; created if IOC(10) = 1 (output).

Notes on Entering Data

The following data entry alternatives can be used when requested to enter a list of numbers or coordinate pairs: (1) Each number may be entered on a separate line, (2) a comma or one or more spaces may be used as the delimiter, or (3) a combination of commas and spaces may be used. Examples of coordinate pair entry follow.

- Entered on a separate line
  0.00—velocity
  1.00—index
  1.00—velocity
  0.25—index
- Separated by commas
  0.00, 1.00
  1.00, 0.25
- Separated by commas and spaces and entered on the same line
  0.00, 1.00 1.00, 0.25

Job Recovery

When logging on to the computer, write down the job serial number (JSN). If communications between your terminal and the computer are interrupted, or if the computer logs you off (this occurs when the terminal has been idle for 10 min), you may recover the work you were doing if you know the JSN (XXXX in the previous examples).

To recover, call back within 30 min and log on to the host computer. After the computer information or note, you will get a listing of recoverable jobs.

```
RECOVERABLE JOB(S)

JSN    UJN     STATUS       TIMEOUT

XXXX   ZZZZ    SUSPENDED    28 MIN. [time left to
AAAA   DDDD    SUSPENDED    15 MIN.  recover
before it is
permanently
dropped]

ENTER GO TO CONTINUE CURRENT JOB,
RELIST TO LIST RECOVERABLE JOBS,
OR DESIRED JSN:
```

Entering the JSN of the desired job will recover the job and place you at the point within the job where it was dropped. Remember, jobs must be recovered within 30 min. If you do not wish to recover any of the listed jobs, enter GO to continue the job (new JSN) that you have just begun.

Logging Off of a Cyber Computer

Log off by typing BYE when you have completed a terminal session.

File Information

A file is a named collection of information, such as a program or data. A filename can be from 1 to 7 alphabetic or numeric characters in length. All files used with PHABSIM and TSLIB must begin with an alphabetical character.

There are four major types of files:

Local Files. Local files are files created for the duration of a terminal session. They are lost when logging-off of the computer if they are not stored as a Permanent file using the SAVE or REPLACE command. ALL file manipulations MUST be done in local file space. The only exceptions for this rule are the CHANGE and PURGE commands.

Permanent Files. Permanent files are files that are saved from session to session.

System Files. System files are files, created by the computer system, that are used for internal purposes.

Procedure Files. Procedure files are special files containing executable procedural information. The entire Aquatic Systems Branch repertoire of programs and models can be accessed with developed procedure files. The PHABSIM procedure files are stored in PHABPRC and the TSLIB procedure files are stored in TSPROC.

NOS System Commands

The CDC Cyber computer utilizes the network operating system (NOS). Following is a list of commonly used NOS commands. Refer to the *NOS Version 1 Reference Manual,* published by Control Data Corporation, for additional information.

lfn = local filename
pfn = permanent filename

BAT— Puts terminal in the BATCH subsystem. Prompt is "/".

CATLIST— Lists permanent filenames.

CATLIST, FN=MY******— Lists permanent files beginning with "MY".

CATLIST, LO=F, FN=pfn— Lists detailed information on file pfn.

CHANGE, newpfn=oldpfn— Renames a permanent file.

CLEAR— Deletes all local files.

COPY,lfn— Lists a local file on the terminal.

COPYSBF, lfn1,lfn2— Copies lfn1 into lfn2 with a space in column 1.

DAYFILE,lfn— Dumps dayfile to file lfn (see following Note[a]).

GET,pfn— Makes a copy of an indirect access permanent file in local file space.

GET,pfn/UN=SAS6SWT— Gets a file from another user's permanent file space.

PURGE,pfn— Deletes a permanent file.

RENAME, newlfn=oldlfn— Renames a local file.

RETURN,lfn— Deletes a local file.

REPLACE,lfn— Replaces the permanent file with the same name as lfn with the local file lfn.

ROUTE, lfn,DC=LP,ID=O— Prints lfn at the central site with "myname"
UJN=myname— (7 letters) in the banner.

RWF— Rewind all local files. Errors often result from programs attemping to read files that have not been rewound.

SAVE,lfn— Makes a permanent copy of the local file lfn.

STATUS,F— Lists local filenames.

[a] The dayfile contains a summary of all control statements, information, and error messages. Typing "DAYFILE,lfn" will cause the DAYFILE to be dumped to the specified local filename, where it can be reviewed with an editor.

XEDIT Commands

XEDIT is a line-editor used to create, modify, or merge text files. The following information is helpful when working with XEDIT. Refer to the *XEDIT Reference Manual* for more information.

??—Prompt to enter a command.

?—Prompt to enter data.

Delimiter—Character used to separate parts of an XEDIT command. For example, in the command CS/SANKE/SNAKE/, the "/" is the delimiter. It is best to use special characters (such as "; / @") as delimeters so they can be distinguished from text material.

Pointer—Line in the file at which the computer is currently "looking." All commands operate on the current line or subsequent lines. When the pointer reaches the end of a file, it is set back to the top of the file. If you are unsure where the pointer is positioned, print one line.

XEDIT,lfn—Edit a local file called lfn.

ABORT [or Stop]—Exit XEDIT without updating the file (on some computers, user must type STOP rather than abort).

ADD [A] —Add a string to the end of the current line (the system responds with a "?" prompt; type the data to be added).

BOTTOM [B]—Move pointer to bottom of the file.

CHANGE [C;string1;string2;!]—Find first line containing string1; change all occurrences of string1 to string2 within that line.

CHANGE STRING [CS;string1;string2;!]—Change first occurrence of string1 to string2.

COPY lfn n—Copy n lines from the file being edited to a file named lfn.

-CR- —Carriage return; it works as
1. Entry terminator (normal end of line),
2. Enter input mode to insert any number of lines,
3. Terminate input mode.

DELETE [D]—Delete current line.

[D3]—Delete 3 lines starting at current line.

END—End editing, updated file is a local file.

INSERT [I]—Insert line after the current line (prompt is "?").

[I6]—Insert 6 lines after the current line.

LOCATE [L;string;]—Locate the first occurrence of string.

[L;button;*]—Locate all occurrences of "button" from current position to end of file.

MODIFY [M]—Modify the current line (the line is printed; space the cursor to the change point and replace characters as needed, "&" replaces with a space, "#" deletes a character and closes the space).

NEXT [N]—Move the pointer to the next line down.

[N4]—Move the pointer 4 lines down.

PRINT [P]—Print the current line.

[P5]—Print 5 lines and moves pointer to fifth line.

READ lfn—Read a file lfn into the edit file below the current line.

TOP [T]—Move the pointer to the top of the file.

TOPNULL [TN]— Move the pointer to the top of the file and insert a blank line as the first line of the file.

WHERE [W]— Print the current line number.

X (prefix)— Suppress verification, as in XCS; str1;str2; (changes string without printing changed line).

/ (prefix)— Advance pointer 1 line before executing the command.

^ (prefix)— Go to the top of the file before executing the command.

* (suffix)— Repeat the command for all occurrences from pointer position to the bottom of the file, as in P* (prints all lines of a file from the current line to the bottom of the file).

.— Advance the pointer 1 line and then repeat the previous command.

Appendix F. Time Series User Interface

Introduction

The Time Series Library user interface (RTSM) is a hierarchical menu-based system structured to follow the organization in this manual. The system is designed to provide an integrated working environment in which the user has a brief on-line description of each active menu function as well as access to more detailed help. A dialogue box is provided, where each program's default input and output filenames can be changed. In addition, several useful file management functions are provided. Those users familiar with the PHABSIM user interface (RPM) will have no difficulty getting started with RTSM.

Installing the Time Series User Interface

This text explains how to prepare a system to use the RTSM user interface for the TSLIB programs.

First, refer to Appendix D for the appropriate method to install TSLIB on your hard disk. In particular, the DOS path must be set properly to proceed with the installation. In addition, the DOS mode command must be accessible through your path.

The following programs must be in the same directory as the other TSLIB programs for the TSLIB user interface to work[a]:

PM.COM, PMINSTAL.EXE, TSBAT.DAT, TSHELP.HLP, RTSM.BAT, TSLONG.FIL, TSSHORT.FIL, TSLOGO.EXE

Change to your data directory and start the interface by typing RTSM and pressing ENTER at the DOS prompt. If this is the first time RTSM has been used, the installation program will be invoked and allow you to change a set of five selections to create a special file called TSDEF.DEF. If you wish to change the set-up of your user interface at any time, you may reinstall by typing PMINSTAL TS[b] at the DOS prompt. It would be a good idea to review the selections before the installation is performed. An example of the installation screen is shown in Fig. F.1; an explanation of each selection follows.

1. COLOR:

   If your computer has a color monitor, press the down arrow to go to the next selection; otherwise, press the space bar for a monochrome monitor.

2. EDITOR:

   Type the name of the ASCII text editor (e.g., **WED, PE, TED**) you wish the user interface program to use. The DOS editor EDLIN is the default editor, but we

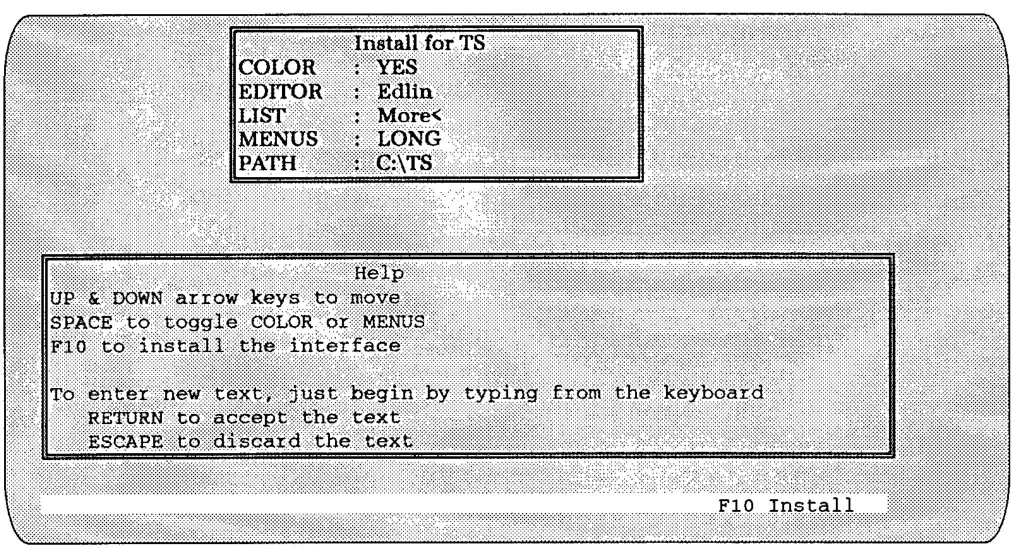

Fig.F.1. Initial menu for the FSLIB user interface.

[a] Note that the programs PM and PMINSTAL are the same for both TSLIB and PHABSIM.
[b] If you wish to reinstall PHABISM, type PMINSTALL PM.

do *not* recommend its use. Type the name of the editor you have installed on your system followed by enter. (Your editor must be accessible through the DOS path.)

3. LIST:
   Type the name of your browse utility (e.g., **LIST, BROWSE**) that you wish the user interface program to use. The DOS command **MORE<** is the default listing program, but we do *not* recommend its use. Type the name of the lister you have installed on your system followed by enter. (Your lister must be accessible through the DOS path.)
4. MENUS:
   For RTSM, there is no distinction between long and short menus. This selection has been maintained for compatibility with PHABSIM, for which the short menus are used in the teaching courses, and contain the programs covered in those courses as well as other commonly used programs. The long menus contain all programs in the PHABSIM system. For RTSM, press the down arrow to the next selection.
5. PATH:
   Type the drive and full pathname (e.g., **C:\TSLIB**) where the TSLIB programs have been placed. You *must* type this correctly; otherwise, the user interface program will not know where to find the TSLIB programs.
6. F10:
   When all selections have been made, pressing the **F10** key will complete the installation process. A file named TSDEF.DEF[c] will appear in your default directory. This file contains the answers to the selections you have made.

General Program Usage and Control

To start the TSLIB user interface, type **RTSM** at the DOS command line in your data directory (or from wherever the PMINSTAL program was run), followed by **Enter.**

The initial hierarchial menu structure will appear on the screen, looking similar to Fig. F.2. Movement within or between menus is accomplished with arrow keys. Enter or a carriage return will select the menu option when that particular option is highlighted. The next level of the interface hierarchy is shown for each highlighted function.

Additional program options assigned to specific function keys (as indicated at the bottom of Fig. F.2) can be selected by pressing the desired function key. Only functions appropriate for the existing menu choice are displayed. The Esc key is used to back up (return to previous menus) through the hierarchical structure of the menus or to quit the program. A listing of the entire menu structure can be found in Table F.2.

Using the RTSM Interface

You can move through the available options within each menu by using the up or down arrow keys. The highlighted menu option can be selected by either pressing **Enter** or using the right arrow key. Note that at the top of the page, a 1-line description of the highlighted menu option is displayed. Figure F.3 provides an example of the screen where

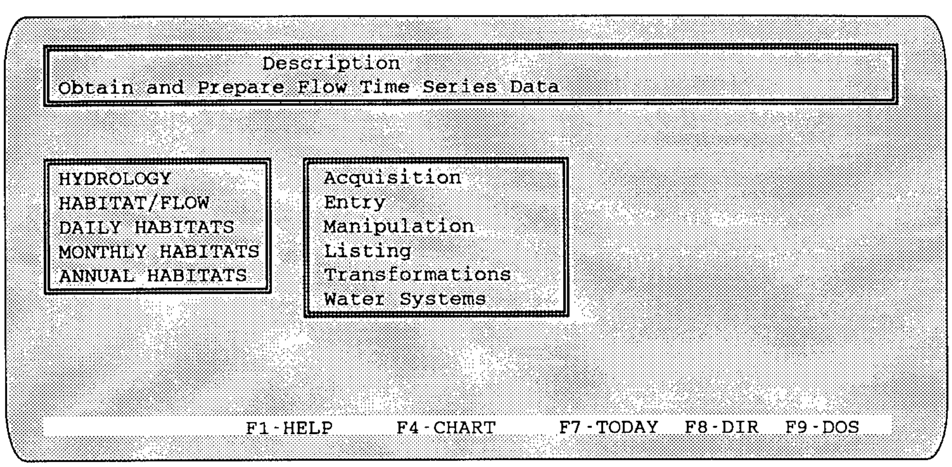

Fig. F.2. Initial hierarchical menu for the TSLIB user interface.

[c] If installing PHABSIM, the file will be named PMDEF.DEF.

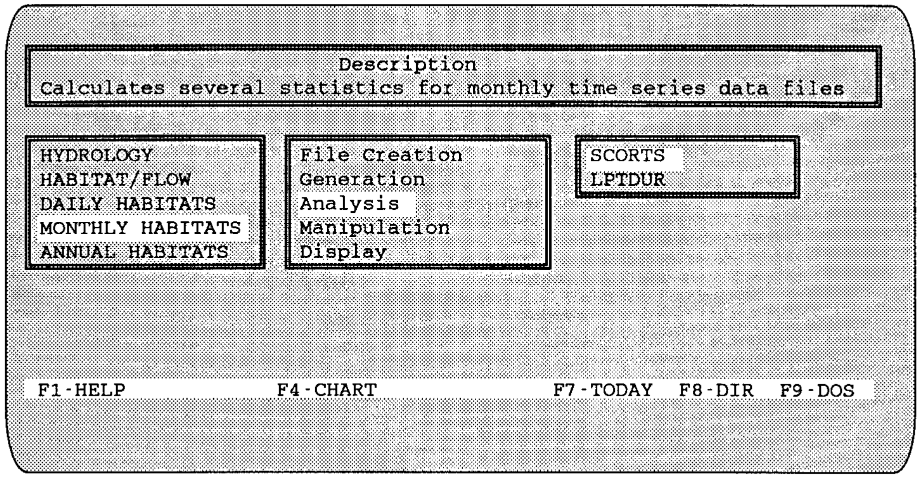

Fig. F.3. Screen showing hierarchiacal structure of the menu system.

MONTHLY HABITATS, Analysis, and the program **SCORTS** have been selected. You can obtain additional help on any selected menu item by using the **F1** key while on that option, as shown in Fig. F.4.

If you desire to run a particular program, such as the **SCORTS** program shown selected in Fig. F.3, **Enter** will display a dialogue box containing the default input and output filenames used by convention in *Instream Flow Information Paper 27.* The system also displays additional information about the selected program to aid you as shown in Fig. F.5.

You may change any of the filenames by using the arrow keys to highlight the appropriate file, then typing a new complete name from the keyboard. The system will automatically substitute the revised filename(s) in all other program dialogue boxes that used the original filename.[d] This automatically preserves the linkage between program units that utilize common default filenames.

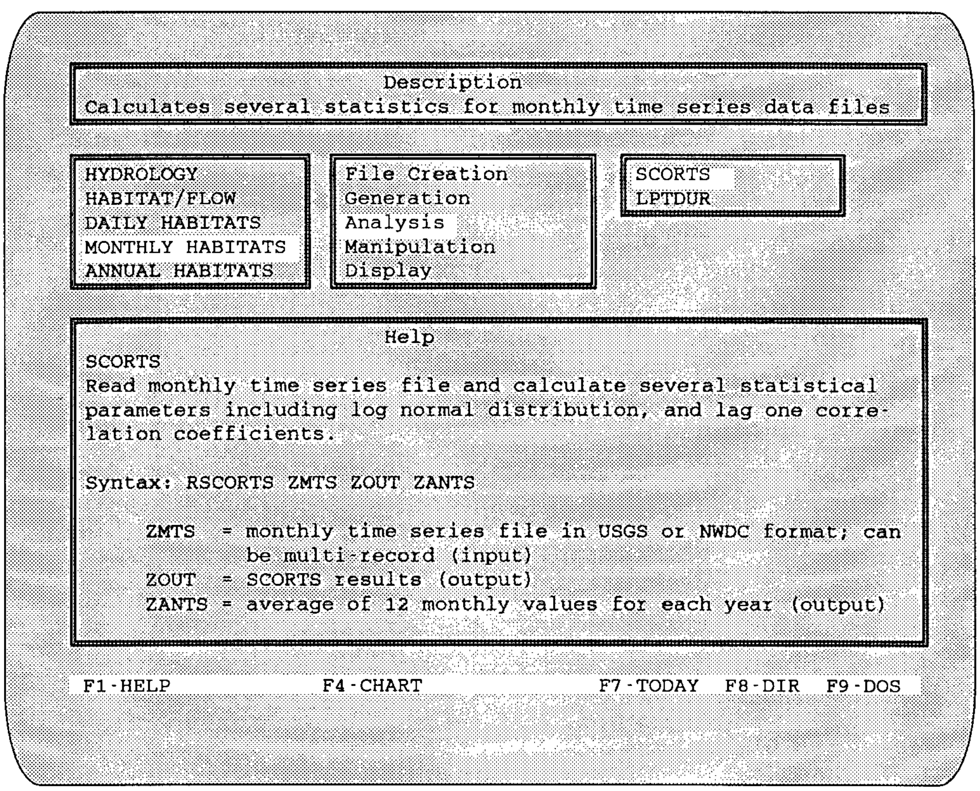

Fig F.4. Example of help screen displayed by using the **F1** key.

[d] Note that an exception to this rule is any filename that begins with the letters **ZOUT.**

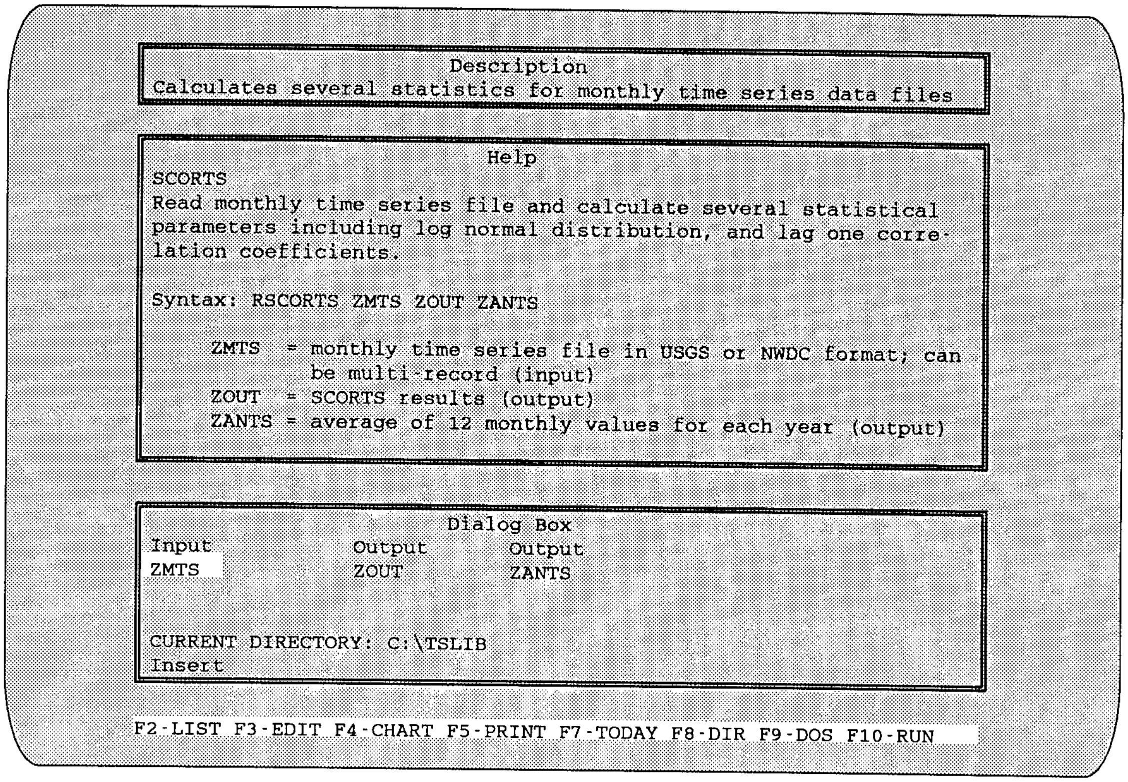

Fig. F.5. Example of dialogue box and program description.

A filename may also be changed in the dialogue box by moving the cursor to the desired position and pressing the **F8** function key. This will allow you to specify a file specification (the default is *.*), as shown in Fig. F.6; then, the system will display any matching filenames in a window as indicated in Fig. F.7. You can then cursor down or up to the desired file and press **Enter**, which will automatically substitute this file in the highlighted position of the dialogue box. The **F7** (TODAY) function will also allow this file name substitution.

Once you are satisfied that the appropriate files have been selected for input and output, the program can be invoked by pressing the **F10** function key. No action will be taken unless this key is pressed. To exit the dialogue box without running the program, press the **Esc** key.

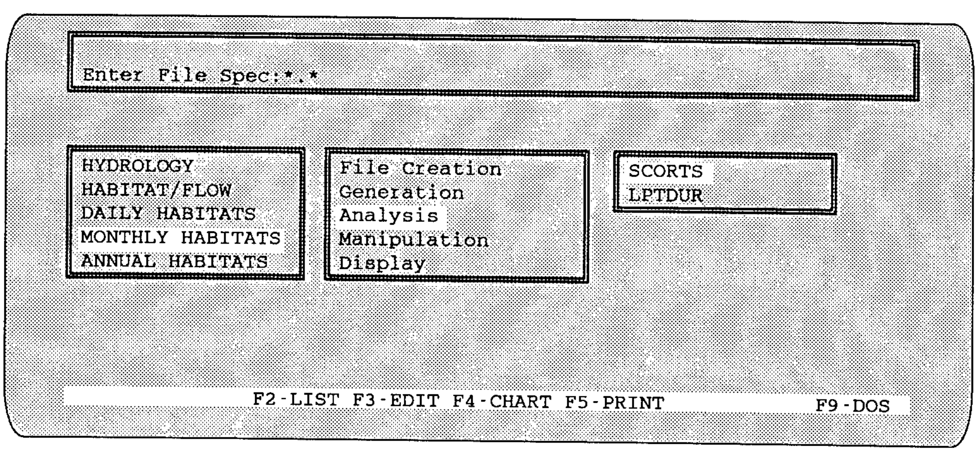

Fig. F.6. Example of using the F8 function key to display a directory.

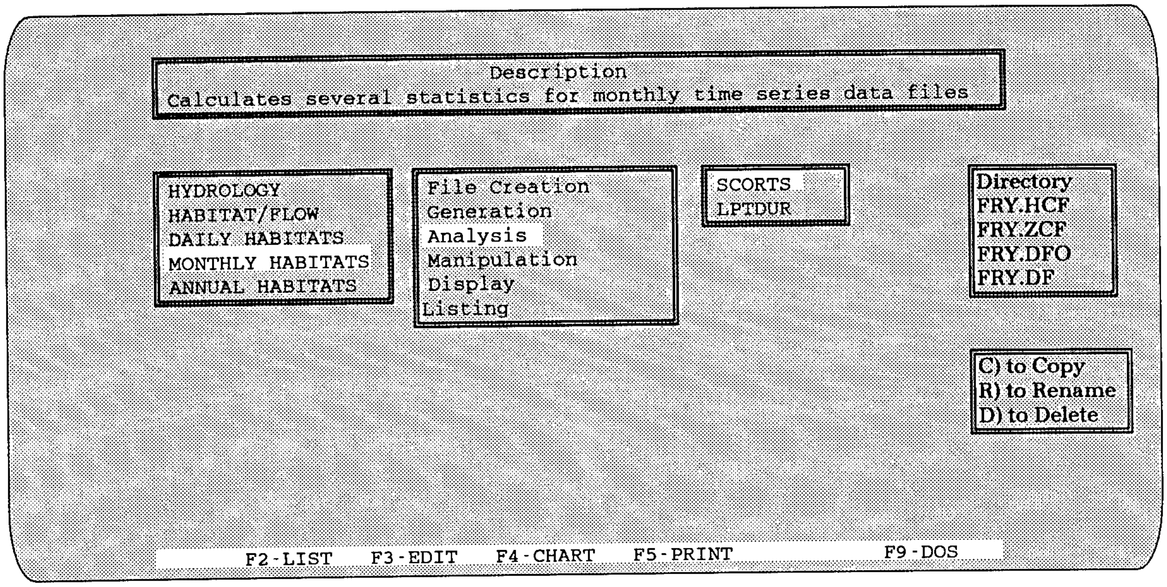

Fig. F.7. Directory window obtained by using the F8 function key.

The RTSM program runs the TSLIB programs by inserting R in front of the program name displayed on the screen. If for any reason RTSM cannot find the program you have asked to be run, a message will be displayed. If this occurs, check to be sure you have copied all TSLIB distribution disks and set your path properly.

The user interface may be exited by repeatedly pressing the **Escape** key and answering **Yes** to the exit prompt. Following this prompt, you will be asked if you wish to save the current filenames. Answering **Yes** to this prompt will retain your default filenames for the next time RTSM is run. Answering **No** will result in the original TSLIB default filenames the next time RTSM is run.

Editing Filenames in the Dialogue Box

Pressing the **Enter** key will move from one filename to the next in the dialogue box. Editing the filenames may be accomplished in two distinct modes: insert and typeover.

Table F.1. *Dialogue box editing functions.*

Key	Action	Key	Action
→	Foward one character	←	Backward one character
Enter (↵)	Forward one field	Ctrl ↵	Back one field
Tab (⇥)	Position on first character	Tab (⇤)	Position on first character
Ctrl →	Position on first character	Ctrl ←	Position on first character
Delete	Remove character under cursor		
Backspace	Remove character before cursor		
Esc	Leave dialog box without saving filenames		
Insert	Switch modes (insert is initial default)		

Key	Insert mode action	Typeover mode action
Home	Beginning of field	Beginning of first field
End	End of field	End of last field
Valid letter on first character	Erase name and begin a new name	Replace character under cursor
Valid letter on any other character	Insert letter in name at cursor	Replace character under cursor

These modes work much like those in other popular microcomputer programs and will facilitate either total name replacement or minor editing. Some users may prefer one mode to the other—however, the proficient user will find it useful to switch back and forth as the need dictates.

The functions supported are listed in Table F.1. Pressing the **Insert** key toggles between insert and typeover modes. The mode is indicated near the bottom of the dialogue box as shown in Fig. F.5.

Note that as filenames are accepted, they will appear in uppercase characters. Specifying input files not found in the current directory will result in an informative message.

Use of Function Keys

The function keys indicated at the bottom of each screen can be used at any time. The system will take no action if the selected function is not appropriate for the selected menu option. The particular use of each function key is as follows:

F1—Help:

The **F1** key will display a window containing additional help for the presently selected menu option. The **Esc** key will return the user to the currently active menu choice.

F2—List:

The **F2** key is active from within the directory window obtained from use of the **F7** or **F8** key or within the dialogue box. **F2** will show the contents of the selected file in the directory window. The particular list utility for your system is specified during the initial system setup and is the DOS **MORE<** command by default

F3—Edit:

The **F3** key allows access to the editor that the user specified during the initial system set-up. The default editor is the DOS EDLIN utility.

F4—Chart:

The **F4** key places the user into the TSLIB on-line help utility (RHELP). This function for TSLIB is not currently available.

F5—Print:

The **F5** key allows the user to print the highlighted filename from within the directory window or dialogue box. The file's name, creation date and time, and current date and time, with an optional user-entered file description, will appear at the top of the page, followed by the file contents. Note that only ASCII files can be printed with confidence; printing non-ASCII files may cause unpredictable results.

F7—Today:

The **F7** key allows the user to obtain a directory window showing all files created today (i.e., the DOS dates that match the computer's clock date). See the **F8** key's description for capabilities available once the directory window is displayed.

F8—DIR:

The **F8** key allows the user to obtain a directory window with all files matching the file specification. The user can scan the list by scrolling through the window with the up or down arrow keys. If the dialogue box is active at the time **F8** is used, **Enter** can be used to move the selected filename in the directory window to the selected position within the dialogue box.

Pressing **F2** while the cursor is in the directory window will display the selected file with the user-specified list utility. Similarly, pressing **F3** will allow easy file editing.

In addition, the common file functions copy, rename, and delete are available in the directory box. You will have no trouble with these functions.

F9—DOS:

The **F9** key will allow the user to go to the DOS command line. This is handy for file management and other functions. The user returns to the user interface when finished by typing EXIT at the DOS prompt. This will be signified by "Enter 'EXIT' to return to interface", displayed above the DOS prompt. You must type EXIT and press Enter to return to the user interface program. Do not try to return to RTSM or RPM by typing their names—this would only load another copy of the menu program into memory. While in DOS, do not use the **CHKDSK/F** or install other memory resident programs such as PRINT. Using RENAME or DELETE may cause problems if you have pressed **F9** while inside the directory window of the user interface. Finally, pressing **F9** will create a local file called PMSHELL.BAT.

F10—Run:

The **F10** key is used to invoke a specific program from the dialogue box. This is the only window in which this key is active.

Note: Function Key 6 is reserved for future use.

Table F.2. *Hierarchical menu structure of the time series user interface*

HYDROLOGY—Obtain and prepare flow time series data for analysis

Acquisition—Assist in WATSTORE preprocessing
- **MESS**—Generates a WATSTORE message request file
- **GETREL**—Generates a WATSTORE tape reel numbers file
- **DAILY**—Generates a WATSTORE mean daily streamflow request file
- **DURTBL**—Generates a WATSTORE duration table request file
- **INVENT**—Generates a WATSTORE station inventory request file
- **PEAK**—Generates a WATSTORE peak streamflow values request file

Entry—If you must enter data by hand, this is the place
- **QIN**—Creates daily or monthly streamflow data file
- **CHGFMT**—Changes a monthly USGS format to NWDC or vice versa

Manipulation—Modify daily time series data files
- **DQFY**—Removes incomplete years from a WATSTORE daily streamflow file
- **DQTOMQ**—Creates a monthly streamflow file from a daily streamflow file
- **PAGEBR**—Prepares a WATSTORE output file for formatted listing
- **SELDUR**—Reduces a WATSTORE duration analysis file

Listing—Organize daily time series data for orderly printing
- **CEDUR**—Reports 6 sets of statistics for a daily streamflow data file
- **LSTDQ**—Segregates a WATSTORE daily streamflow file by header or water year

Transformations—Transfers streamflow from one geographic site to another
- **TRANMN**—Transfers monthly streamflow using equation
  Qnew = A*(Qold)**B
- **TRANMR**—Transfers monthly streamflow with 3 options
- **TRANTS**—Transfers annual streamflow from long to short record site

Water systems—Analysis of flow manipulation systems
- **QABSDY**—Subtracts a diversion flow by day from a daily flow file
- **QABSMN**—Subtracts a diversion flow by month from a monthly flow file
- **RESYLD**—Operates a single reservoir with monthly flows
- **RESIN**—Creates an input file for the RESYLD program
- **CHGMIN**—Changes minimum flow values in a RESYLD input file
- **RESYI**—Computes the yield index for a reservoir
- **RSTOMQ**—Creates a monthly flow file from the ZRES output file from RESYLD

HABITAT-FLOW—Prepare habitat area-versus-flow function for analysis

Entry—Enter habitat area-versus-streamflow function data
- **CRHAQF**—Creates a habitat area-versus-streamflow file

Manipulation—Modify habitat-versus-streamflow functions
- **COMHQF**—Sums or combines 2 ZHAQF files with user-supplied weights
- **HAQINT**—Estimates habitat area from a ZHAQF file by interpolation
- **MRGHQF**—Selectively extract life stages from 1 or 2 ZHAQF files
- **MULHQF**—Scales life stages habitat areas in a ZHAQF file
- **NRMHQF**—Normalizes habitat values in a ZHAQF file to a specified flow
- **SUMHQF**—Sums conditional cover columns in a ZHAQF file to a single life stage

Listing—Organize habitat-versus-streamflow functions for orderly printing
- **HABOUT**—Sorts ZHAQF file by monthly flows and calculates adult equivalent habitat
- **HBOUTA**—Formats ZHAQF data file for printing

Table F.2. *Continued.*

Display—Plot graphs of habitat-versus-streamflow functions
LPTHQF—Plots a ZHAQF data file one species per page

DAILY HABITATS—Calculate–analyze habitat values based on daily flows
Generation—Calculate habitat values based on daily flows
HABTD—Calculates daily habitat time series then converts to monthly series

Analysis—Calculate daily streamflow statistics
DQDUR—Calculates exceedence probabilities from WATSTORE duration file

MONTHLY HABITATS—Calculate–analyze habitat values based on monthly flows
File creation—Assist in file preparation for HABNET
HABINN—Creates a HABNET options file
HQFMON—Creates a HABNET ZHAQFM-type file
QTEM—Creates a HABNET temperature-versus-flow equation file

Generation—Calculate monthly habitat time series
HABTS—Calculates monthly habitat time series for multiple species–life stages
HABNET—Networkwide monthly (temperature-conditioned) habitat time series

Analysis—Calculate monthly time series statistics
SCORTS—Calculates several statistics for monthly time series data files
LPTDUR—Calculates exceedence statistics for 1 or 2 monthly time series files

Manipulation—Modify monthly time series data with algebraic functions
CHGFMT—Changes a monthly USGS format to NWDC or vice versa
COMMTS—Calculates a weighted sum of 2 USGS monthly data files
MULMTS—Multiplies a monthly time series data file by a constant
SELMTS—Selective extraction of months from 2 or more monthly data files
GET1—Extracts records from a multirecord file

Display—Plot graphs of monthly time series data
LPTQHA—Plots 1 or 2 monthly time series file, approximately 5 years per page
LPTTSN—Plots up to 5 monthly time series files

Listing—Organize monthly time series data for orderly printing
MTSLST—Formats a monthly time series data files (to LOTUS 1-2-3)

ANNUAL HABITATS— Calculate–analyze habitat values based on annual events
File creation—Prepare data files for annual habitat time series analysis
EFFIN—Creates input file for EFFHAB
EFFIN2—Creates input file for EFFHB2

Generation—Calculate annual habitat time series
ANNTS—Calculates an annual habitat time series from monthly data
ANEQTS—Calculates annual equivalent adult habitat time series
EFFHAB—Calculates an effective adult habitat time series for four life stages
EFFHB2—Calculates an effective adult habitat time series for odd life cycles

Analysis—Calculate exceedence statistics for annual time series
LPTDAN—Calculates exceedence statistics for annual time series

Display—Plot graphs of annual exceedence values
LPTDAN—Calculates exceedence statistics for annual time series

Appendix G. Running WATSTORE on the USGS Amdahl Mainframe Computer

To access WATSTORE, users must have a valid account on the USGS Amdahl mainframe computer in Reston, Virginia. Such accounts can be opened by contacting

NAWDEX Chief of User Services
U.S. Geological Survey
421 National Center
Reston, VA 22092
(703) 648-5664 or FTS 959-5664

Users manuals will be provided by the U.S. Geological Survey.

The DAILY, DURTBL, INVENT, MESS, and PEAK programs have been developed to provide users with a method for retrieving information from WATSTORE. These programs interactively prompt the user with a series of questions pertaining to the type of data desired. After the questions are completed, an output file is produced in the form of a WATSTORE request job. This file is transferred to the USGS Amdahl mainframe computer using a communications software package and is submitted for execution on the Amdahl. Users are responsible for obtaining their own communications software package.

Step 1: Set the Communications Parameters for the Amdahl Computer

BAUD:	300–2400
PARITY:	MARK
WORD BITS:	7
STOP BITS:	1
ECHO:	YES
MESSAGES:	NO
PACE OR PAUSE:	.5 S FOR UPLOADING FILES

> Note: If you see colons at the beginning of each line on the WYLBUR system, you may remove the colons with a "Strip characters" function (if the communications software you are using offers such a function).

Step 2: Logging On to the USGS Amdahl Computer

The following telephone numbers are used to dial the Amdahl computer:

FTS—1200 baud—8,959,4100
FTS—300 baud—8,959,7800
Commercial—1200 baud—1,703,648,4100
Commercial—300 baud—1,703,648,7800

```
CONNECT
```

When CONNECT appears on the screen, you have successfully logged on to the Amdahl computer. Enter a carriage return to continue. Note: For this documentation, user responses will be **bold** and underlined.

(carriage return)

```
CALL,DISPLAY, OR MODIFY?
```

C

```
ENTER NUMBER?
```

AMDAX

```
CALLING [a number will be displayed here]
```

Do not worry if the response is slow or garbled. There will be a several second delay, and then the message:

```
CALL COMPLETE
```

Enter a carriage return.

(carriage return)

> Note: If you cannot connect to the computer immediately, try again. It may take several trys. If you do get on but become disconnected, use the RECONN command to get back on. You will be returned to the same place you were when you were disconnected. To use RECONN, type RECONN immediately after your log-on ID (on the same line).

```
USS327X USGS AMDAHL 5890 CROSS DOMAIN SERVICES
PLEASE ENTER "VM", "TSO", "M204A", "M204B", "WYLBUR", "CICP",
OR "CICT"
```

The above message will appear. In this documentation, you will be logging on to TSO to upload your request files and to submit them for processing. You will then log on to WYLBUR to retrieve your output.

Step 3: Logging on to TSO and Uploading Files to the Amdahl Computer

TSO

```
USS327X-USS LOGON ACCEPTED
```

Here, you will be asked for your log-on ID and your password, as assigned by the person who initiated your account.

```
ACF82003 ACF2, ENTER LOGON ID-
ACF82004 ACF2, ENTER PASSWORD-
```

A series of lines will be printed. When you see the following line, enter a carriage return.

```
ACF82021 ACF2, ENTER OVERRIDES OR HIT ENTER TO CONTINUE
```

(carriage return)

```
JGWD65M LOGON IN PROGRESS AT 13:01:48 ON APRIL 4, 1990
```

The next 2 lines are messages that are listed every time you log on. It may take several seconds for them to complete. Remember, be patient!

```
NO BROADCAST MESSAGES
DATA SET STARTUP.CLIST NOT IN CATALOG OR CATALOG CAN NOT BE
 ACCESSED
READY
```

You are now logged on. Congratulations! When the "READY" message is displayed, you can begin. To see which files, if any, are present on the account, enter:

LISTC

You are now ready to transfer your request file(s), created by the DAILY, DURTBL, INVENT, MESS, or PEAK programs, using your microcomputer communications software package.

First, create a file in which to transfer the request file by using the EDIT command. This file can have any name not already on the account but must end with ".CNTL". To create a new file, substitute the name of your choice for "MYJOB". Include the words "NEW" and "NONUM" to specify a new file without line numbers.

EDIT MYJOB.CNTL NEW NONUM

```
INPUT
```

You have created a new file in which to place the request file. When the "INPUT" prompt appears, the computer is ready to accept the request file. Begin the file transfer using your microcomputer communications software package.

When the file transfer is complete, wait several seconds, then exit the input mode by pressing:

(carriage return)

Now you are in the edit mode and the following message is displayed:

```
EDIT
```

Check the file to verify that the file transfer encountered no errors by using the L command. Simply enter L at the edit prompt and press the return key. If errors exist, do not save the file. Exit the editor and return to the step that creates a file—the edit command.

To save and exit the request file, enter the following two commands:

SAVE

```
EDIT
```

END

You may now submit the job for processing with the SUBMIT command.

Step 4: Submitting a Job for Processing

SUBMIT filename (MYJOB.CNTL was filename of previous example)

```
ENTER JOBNAME CHARACTER(S) -
```

This can be any letter or number, but use a different one for each job to ensure that your jobs have unique names.

After a character has been entered, the computer will respond with the following message:

```
JOB ABCD123A (JOB04133) SUBMITTED.
```

Your job is now in queue for execution. Remember the job number (4133 here) and write it down. To keep track of the job's progress, use the "STATUS" command.

STATUS

You will get one of the following messages to inform you of the status of your job. The message that you get will depend on the amount of data you requested and priority level you assigned to the job.

```
JOB ABCD123A (JOB04133) WAITING FOR EXECUTION, IN HOLD STATUS
READY
```

This message indicates that the computer is waiting to process the request file. You may want to wait a few minutes and then check the status again. If the job is still in the hold status, you may want to log off and then log on later to retrieve your output. To log off completely, type LOGOFF to log off TSO, and then type LOGOFF again to log off the Amdahl.

When you redial the Amdahl to retrieve your output, log on to WYLBUR (instead of TSO) and then follow the instructions in Step 5 to retrieve output from the WYLBUR fetch queue.

```
JOB ABCD123A (JOB04133) EXECUTING

READY
```

This message indicates that the request file is being processed. You may want to stay logged on for a few minutes until the status is "on output queue".

```
JOB ABCD123A (JOB 04133) ON OUTPUT QUEUE
```

This message indicates that the request file has been processed. Log off of TSO by typing LOGOFF and then log on to WYLBUR to retrieve your output. Follow the instructions in Step 4 to retrieve output from the WYLBUR fetch queue.

Step 5: Output Retrieval from the WYLBUR Fetch Queue

When logged on to the WYLBUR system, there are four basic commands you will need to use:

- LOC (locate) will list the files on your account.
- FETCH command will place a copy of a file in your local file space where you can manipulate and view it. There can be only one file in the local space at any given time, so if you wish to view more than one file during a session, the local file space must be cleared. The system will supply the prompt "OK TO CLEAR?" if you use the FETCH command when the local file space is not empty. Respond by entering "OK". This does not affect the permanent copy of the file that was in the local file space.
- PURGE deletes a permanent file. Enter PURGE and the associated job number to identify the file you wish to delete.
- LIST command (explained in greater detail in "Using the LIST command on the WYLBUR system").

For more information on WYLBUR commands, enter H HELP at the "COMMAND?" prompt.

To retrieve your output, follow the steps outlined in "Logging on to the USGS Amdahl computer" and then enter "W" to log on to WYLBUR.

```
WELCOME TO MVS WYLBUR 7.0 TERMINAL TERM45

USER ID? ABCD123 (used on this documentation)

KEYWORD? PASSWOR

ACCCTNO IN EFFECT:
*****************************************
ENTER "H NEWS" FOR SYSTEM BULLETINS
*****************************************

ABCD123.LIB NOT ON CATLG

EXEC BREAK
```

To locate your job in the WYLBUR Fetch Queue, enter the LOC command and look for the job's 4-digit job number. Also notice the job name character appended to the end of your user ID.

```
COMMAND? LOC

JOB 4133 ABCD123A AW FETCH
```

Job 4133 is present in the WYLBUR fetch queue. Use fetch to get it. The job number was assigned when the job was submitted for processing (4133 here).

```
COMMAND? FETCH [job number]
```

To list it on the terminal screen use the L command. See "Using the LIST command on the WYLBUR system" for more information.

```
COMMAND? L 1/10
```

This command will display the first 10 lines, which contain some job diagnostics messages. By viewing the first 10–15 lines, it should be apparent whether or not the job was successful. The size of the file can also be an indication if you have an idea of how much information should have been retrieved by the job.

Before the actual WATSTORE processing information and data, there are 200–400 lines of job diagnostics and cost information. The series of commands that follow will download the relevant information and data.

List all lines containing "PROGRAM" beginning in column 1 by entering:

```
COMMAND? L 'PROGRAM' 1
```

> Note: When working with the WATSTORE message file, enter L 'DAILY VALUES' instead of L 'PROGRAM' 1.

Set your microcomputer to receive and store the information using your communications software package. Be certain that there is enough space available on the disk to which you direct the file. If the disk fills to capacity during the transfer, there is no easy way

to locate the point in the output file where the transfer ended, and you may be forced to download all the information again. If the information to be received is extensive, it is recommended that an empty formatted diskette be placed in another disk drive and the file downloaded to it or to a hard disk. (A hard disk is faster when receiving data.)

List the WATSTORE processing information and data *without line numbers* with the following command. (Replace the "x" with the line number displayed by the L 'PROGRAM' 1 command.)

L x/LAST UNN

The data transfer is complete when the "COMMAND?" prompt is displayed. Terminate the receiving process.

If you are through with this file on the Amdahl, purge it.

PURGE (job number)

When you are finished, log off.

COMMAND? <u>LOGOFF</u>

OK TO CLEAR? <u>OK</u>

The WATSTORE streamflow data should now be stored on your microcomputer.

Using the "LIST" Command on the WYLBUR System

The list command can be used to locate key words or phrases, determine the length of the output file and display the contents. The syntax of the list command is:

L <range> [<list options>]

range—
Symbolic line numbers that may be used in the range are

FIRST LAST END PREVIOUS CURRENT or *
NEXT

Explicit range:
x—A single line number x.
x/y—Line number x through line number y.
x(z)—z number of lines beginning at x.

Associative range:
[~] ['string'] [m[/n]]

where

~ Means that the string condition has been satisfied if the line does NOT contain the string within the columns searched.

'string' May consist of alphabetic or numeric characters, special characters, and blanks. The null string is also allowed. The string condition has been satisfied when a line contains 'string' in the columns searched.

m/n Restricts the search for 'string' to columns m through n in a given line. If only m is specified, 'string' must begin in that column. If m and n are omitted, the entire line (columns 1 through 133) is searched. When the null string is specified, m/n must be omitted.

LIST options:

[LIST NOLIST] [TEXT NOTEXT] [NUMBERED UNNUMBERED NONUMBER INTEGER]

LIST Causes line to be listed.

NOLIST Prevents lines from being listed.

TEXT Causes the text of the lines to be listed, but not the line numbers.

NOTEXT Causes line numbers to be listed, but no text of the lines.

NUMBERED Causes the text and the line numbers to be listed.

UNNUMBERED Causes the text of the line, but no line number to be listed.

NONUMBER Causes the text of lines that have blanks for line numbers to be listed.

INTEGER Causes the text of lines to be listed. The line number is listed as an 8-digit integer.

For additional information on this command and other WYLBUR commands enter H HELP at the "COMMAND" prompt.

Use the following variation of the list command to locate and display specific sections of the output file. Should you accidentally submit a command that you wish to terminate, press Ctrl-End to send a break sequence to the mainframe. Then, you will be supplied with the "COMMAND?" prompt again.

L 1/10 UNN Lists line 1 through 10 without line numbers.

L LAST Lists the last line of the file and its line number.

L 'PROGRAM' 1	Lists all lines containing "PROGRAM" beginning in column 1 with line numbers.
L x/LAST UNN	Lists lines from line number x through the end of the file without line numbers being displayed.

Step 6: Verifying Data Retrieved from the WYLBUR System

For verification purposes, you may wish to download the WATSTORE data twice, each to an individual file, and then run a file comparison utility. If errors occured during the retrieval, the chance that an error would occur in the same position in both transfers is very remote.

> Note: This step is optional, as the cost of downloading files can be very expensive and you may be limited for disk space.

The file comparison utility described here is the DOS utility, FC. The syntax for FC is as follows:

FC/N f1 f2

where

f1 = name of the first file, and
f2 = name of the second file.

The N option shows the line numbers so that the positions within the file can be found.

Before the file comparison utility is executed, the computer should be set to print all that is displayed on the screen. To initiate this, press Ctrl-P. To terminate printing, press Ctrl-P a second time.

Step 7: Preparing Retrieved Information for Use

There is limited editing necessary before the data is printed for reference or publication. Any ASCII editor may be used. The WATSTORE processing information precedes the data, both printed and punched. In most cases, you will want to remove this portion of the output. This information is important for verification of the parameters and controls used in the retrieval, in addition to messages such as invalid station numbers and dates. At the end of the retrieved file, there may be lines that should be removed. The line(s) to remove include the line containing "COMMAND?" through the end of the file.

Before printing files retrieved from WATSTORE using the DAILY, INVENT, or PEAK programs, the files could be processed by the PAGEBR program to insert printer control characters at the points where printing should begin on a new page. The page breaks are determined by key phrases in specific positions, called headers. In the absence of a header, a control character is inserted every 60 lines.

A summary of the previous preparation process follows:

1. Examine the WATSTORE processing information at the top of the file and remove (if needed or desired) with an editor.
2. Remove line(s) from the end of the file—lines containing "COMMAND?" through the end of the file.
3. Execute the PAGEBR program to insert printer control characters for page breaks.
4. Set the printer at a page break.
5. Set print font to 17 characters per inch.
6. Print file by entering:

PRINT filename or COPY filename PRN

Glossary

Acre-foot That volume of water required to cover 1 acre of land to a depth of 1 foot, equal to 43,560 cubic feet or 1233.49 cubic meters.

Age Class A cohort of organisms, all the same age, born within the same year. In fisheries, an age group is often referred to as Age 0, I, II, III, etc. See Year Class.

Annual Flow The total volume of water passing a given point in one year. May be expressed as a volume (e.g., acre-feet) but may also be expressed as an equivalent constant discharge over the year, such as cfs.

Annual Yield Annual flow per unit area, as cfsm (see CFSM).

Annual Habitat Index A single habitat value you have chosen to be representative of the annual habitat for a given species or life stage. Very often it is the minimum habitat value encountered when time series analysis is used to approximate population bottlenecks; may be the maximum, average, or some other measure of habitat value.

Area, Drainage The surface area tributary to a lake or stream. Sometimes called catchment area, watershed area, or river basin area; we prefer drainage area, which is less geographic and has specific units (square miles) suitable for our purposes.

Area, Usable The area under the wetted surface of a stream that can be used by aquatic organisms. Units: square feet or square meters, usually per specified length of stream.

Area, Weighted Usable (WUA) The wetted area of a stream weighted by its suitability for use by aquatic organisms or recreational activity. Units: square feet or square meters, usually per specified length of stream.

ASCII Acronym for American Standard Code for Information Interchange. The coding scheme was developed by the American National Standards Institute to ensure compatibility between various data processing software and communications equipment. We use ASCII to be distinct from any special word processing data format.

Baseflow The sustained low flow of a stream, usually considered to be groundwater inflow to the stream channel.

Baseline The conditions occurring during the reference time frame, usually referring to water supply, habitat values, or population status. Baseline is often some actual recent historical period but may also represent (1) the same climatological–meteorological conditions but with present water development activities on line, (2) the same climatological–meteorological conditions but with both current and proposed future development on line, or (3) virgin or pre-development conditions. The definition of baseline will *always* depend on the objectives of the study. Quite often, two or more baseline conditions may be necessary to evaluate a specific project.

Batch File A group of operating system commands that enable multiple tasks to be performed. Often called a Procedure file on the CDC Cyber computers.

Biological (or Fish) Year Variously defined. Often used beginning with egg deposition but may be defined as the logical start of any given life stage or phenological relation. In the effective habitat calculations in TSLIB, the biological year is the time of egg hatch or emergence.

Calendar Year 1 January through 31 December (see Climatological Year, Power Year, and Water Year).

Capacity, Carrying The maximum number (or weight) of an organism that can be maintained during that period of least available habitat under a dynamic flow regime. Carrying capacity should be considered a mean value for a specified, short interval (e.g., 1 day, 1 week, 1 month) around which populations may fluctuate.

CFS One cubic foot per second.

CFSM One cubic foot per second per square mile of drainage area.

Climatological Year 1 April through 31 March; used to represent that period from the start of one growing season to another.

CMS One cubic meter per second.

Coefficient of Variation CV; the ratio of the sample standard deviation to the sample mean.

Cohort That group of individuals born within a relatively short period.

Composite In the current edition of TSLIB, composite refers to the simple average of the minimum and the maximum habitat value for a specified portion of the year, based on either monthly or daily values.

Cross Section A transect, across a stream channel, that is perpendicular to the direction of flow.

CUSEC Another way of saying cubic foot per second; not currently in common use.

Curves, Preference See Suitability Curves.

Curves, Suitability-of-Use SI; see Suitability Curves.

Curves, Usability See Suitability Curves.

Default A selection made by a computer program or procedure file if the user does not explicitly choose an alternative.

Discharge The rate of flow, or volume of water flowing, in a given stream at a given place and within a given period, usually expressed as cfs or cms.

Discharge, Bankful Discharge corresponding to the stage at which the overflow plain begins to be flooded.

Drought A prolonged period of less-than-average water availability.

Dry Season That period of a year that is characteristically dry (and has the lowest streamflow), implying an annual seasonal cycle.

Dry Year (or Dry Month) A period with a given probability of representing dry conditions; for example, a given year or month may be as dry or drier than 80% of all other similar periods.

Duration (1) The percentage of time a class of events occur. (2) An event's time span.

Duration Analysis Examination of a certain period of record to categorize the frequency of classes of events within that period.

Effective Habitat That portion of available physical habitat actually occupied by a life stage due to mortality (or other constraint) of previous life stages. Effective habitat analysis implies following cohorts of habitat use through time, as a population-limiting habitat event may not become manifest until some later date.

Equivalent Habitat A measure of one life stage's habitat value in units of another life stage. A common practice is to convert all life stages' habitat values to adult equivalent values—that way, one can assess which life stage is the most limiting at any single time (compare with Effective Habitat). Requires a method for determining the ratio of one life stage's habitat value for that of another.

Evolutionary Time Series A time series with trends; compare with Stationary Time Series.

Exceedence That probability of an event exceeding others in a similar class. Note that this may be "equal or exceed" or "exceed" only. Occasionally, probabilities may be expressed as nonexceedence—that is, the probability of being "less than or equal" or just "less than."

Firm Yield That value of flow, power, or habitat that could be maintained year after year, almost regardless of the circumstances—for example, a reservoir's firm yield might be that amount of water that could be delivered to meet the demand 95% of the time for a specified planning horizon (e.g., 5 years).

Fish Year See Biological Year.

Flood Any flow which exceeds the bankful capacity of a stream or channel and flows out on the floodplain.

Flow The movement of a stream of water or other mobile substances from place to place; discharge; total quantity carried by a stream.

Flow, Augmented Any flow modified to be greater than it would be under natural conditions.

Flow, Enhancement A flow regime that is better (in quantity or quality) than the baseline regime for fish, wildlife, water quality, or recreation.

Flow, Flushing That flow of sufficient magnitude and duration capable of removing fines from the interstitial spaces among the stream bottom gravel and maintains intergravel permeability.

Flow, Natural The flow regime of a stream as it would occur under completely unregulated conditions—that is, not subjected to regulation by reservoirs, diversions, or other human works.

Flow, Regulated Modified natural flow to achieve a specified purpose or objective.

Flow, Steady and Unsteady Flow in an open channel is said to be steady if the depth of flow does not change or can be assumed constant over a specified interval; the flow is unsteady if the depth changes with time.

Function Key A key on an IBM-PC (or compatible microcomputer) labeled F1 to F10 (or F12) that enables certain tasks within the RPM and RTSM software.

Gage, Stream A device for measuring the magnitude of discharge in a stream at a specific location.

HABEF Program A PHABSIM program that calculates the physical habitat considering the conditions at two streamflows or for two life stages or species of fish.

Habitat The place where a population lives and its surroundings, both living and nonliving; includes life requirements such as food and shelter (see Physical Habitat).

Habitat Ratio The amount of adult habitat that can be used at a particular time, given the amount of subadult habitat fully used in previous years or months.

Hydrodata A data base of hydrologic information published on compact disk by Earthinfo in Boulder, Colorado.

Hydrograph A graph showing the variation in stage (depth) or discharge over a specified time.

Hydropeaking The practice of abruptly alternating between a low base and a high peak flow, typically for on-peak electrical power generation; compare with hydropulsing, in which flows may also range from low to high but are gradually varied over a longer period.

Incremental Method The process of developing an instream flow policy that incorporates multiple or variable rules to establish, through negotiation, flow window requirements or guidelines to meet the needs of an aquatic ecosystem, given water supply or other constraints. Usually implies the determination of a habitat–discharge relation for the purpose of comparing streamflow alternatives through time (see Standard Setting).

Index-A The average of the values in a time series for events between 50 and 90% exceedence.

Index-B The average of the values in a time series for events between 10 and 90% exceedence.

Index-C The average of the values in a time series for events between user-specified exceedence levels.

Instantaneous (Peak) Flow The single largest flow measured instantaneously and not averaged over a longer time, such as a day or month.

Life Stage An arbitrary age classification of an organism into categories related to body morphology and reproductive potential, such as spawning, egg incubation, larva or fry, juvenile, and adult (see Cohort).

Low Exceedence See Exceedence.

Macrohabitat Abiotic habitat conditions in a segment of river controlling longitudinal distribution of aquatic organisms, usually describing channel morphology, flow, or chemical properties or characteristics with respect to suitability for use by organisms.

Mean Daily Flow (1) The discharge volume passing a given point averaged over 1 day. (2) The average flow for 1 day computed from several years' worth of data for that day. Usually expressed as cfs or cms.

Mean Monthly Flow (1) The discharge volume passing a given point averaged over 1 calendar month. (2) The average flow for 1 month computed from several years' worth of data for that month. Usually expressed as cfs or cms.

Median Daily Flow That discharge at a given point for which there are equal numbers of greater and lesser flow occurrences during 1 day.

Median Monthly Flow That discharge at a given poi. for which there are equal numbers of greater and lesser flow occurrences during 1 month.

Microhabitat Small, localized areas within a broader habitat type used by organisms for specific purposes or events, typically described by a combination of depth, velocity, substrate or cover.

Operation Rule Criteria by which managers of water projects determine when and how much water to store, release, or divert.

Periodicity That pattern or timing during a biological year when a given organism or life stage is active or present in the system under study.

Persistence A nonrandom process within a time series of hydrological or meteorological events that tend to have high events following other highs and low events following other lows.

PHABSIM (pronounced P-HAB-SIM) The Physical HABitat SIMulation system; a set of software and methods that allows the computation of a relation between streamflow and physical habitat for various life stages of an aquatic organism or a recreational activity.

Plotting Point Variously defined; usually computed as the rank order (m) divided by the number of elements plus one ($N + 1$), resulting in the exceedence value. Note that defined this way, no event will ever have a zero or one exceedence value, which is appropriate for any sample of data.

Physical Habitat Those abiotic factors (such as depth, velocity, substrate, cover, temperature, water quality) that make up a portion of an organisms living space (see Habitat).

Power Year Variously defined; usually begins with the month of the least energy demand.

Preference Curves See Suitability Curves.

Procedure File See Batch File.

Q7–10 The lowest continuous 7-day flow with a 10-year recurrence interval (see Seven Day Minimum).

Reach A comparatively short length of a stream, channel, or shore. One or more reaches compose a segment. The actual length is defined by the purpose of the study but is usually no greater than 5–7 times the channel width.

Reach Length The length of a section or piece of a river.

Recurrence Interval The inverse of the probability that a certain event will occur, normally expressed in years. For example, a flow with a recurrence interval of 10 years would be expected to occur, on average, once every 10 years.

Regime The general pattern (magnitude and frequency) of flow or temperature events through time at a particular location, (e.g., snowmelt regime, rainfall regime).

Rule Curve See Operation Rule.

Scaling A technique for adjusting flows or WUA versus flows to account for a change in location up or downstream from a point of known value. Scaling is usually accomplished by the drainage area ratio technique but may be accomplished by relative stream width or combinations of other factors.

Segment Relatively homogeneous section of a stream composed of one or more reaches (homogeneity almost always refers to at least the channel morphology and discharge within that segment). Boundaries are placed wherever the stream undergoes a significant change in discharge, channel structure, water quality, or temperature, usually at tributary confluences and at major diversions. Usually considerably longer than 10–14 times the channel width.

Segment Length The length (in miles or kilometers) of a reach of stream for which relatively homogeneous conditions exist, allowing characterization of habitat versus flow by a single relation.

7Q10 See Q7-10.

Seven Day Minimum The lowest consecutive 7-day flow (or habitat) occurring during a year. Can also be expressed as a frequency; for example, a one in ten year seven day event.

Shell A computer program that acts as a user-interface to one or more other programs; for example, RPM is a shell for the PHABSIM and RTSM is a shell for TSLIB.

Standard Deviation SD; the positive square root of the variance.

Standard Setting (1) A streamflow policy or technique that uses a single, fixed rule to establish (minimum) flow requirements regardless of dynamic aquatic ecosystem needs. (2) The process of determining minimum flow requirements for a water project or water right. The minimum flow may, to varying degrees, consider generic ecosystem needs (see Incremental Method).

Stationary Time Series A time series of events with no (or minimal) discernable trends.

Steady Flow See Flow, Steady and Unsteady.

Suitability Curves Collectively refers to categories one to four suitability index (SI) curves (see next four entries).

Suitability Curves—Category One or Literature-based The first category of curves, based on available speculative information, including literature sources and expert opinions; usually concerns a species response to or macrohabitat variable.

Suitability Curves—Category Two or Utilization A curve based on frequency analysis of fish observations in the stream environment.

Suitability Curves—Category Three or Preference A utilization curve that has been corrected for environmental bias; for example, if 50% of fish are found in pools over 1.0 m deep, but only 10% of the stream has these pools, the fish are actively selecting that habitat type.

Suitability Curves—Category Four or Conditional A preference curve that is conditioned (stratified) by cover, season, or some other subdivision.

Synthetic Hydrograph A flow time series artificially constructed for a given location through various analytical techniques.

Temperature-conditioned Habitat Total available wetted area computed from the weighted usable microhabitat area adjusted for the relative suitability for stream temperature.

Time Series A record of events (flow, habitat, or other) through time; usually describes those events for a regular averaging interval like hours, days, weeks, months, or years.

Time Series Analysis Analysis of the pattern (frequency, duration, magnitude, and timing) of time-varying events. These events may be discharge, habitat areas, stream temperature, population factors, economic indicators, power generation, and so forth.

Total Habitat Total available wetted area conditioned by both micro- and macrohabitat suitability and summed for all relevant river segments.

Transect See Cross Section.

Trigger A specified condition that indicates when to change from one set of operational criteria (operations rules) to another.

TSLIB A set of computer programs and analytic methods useful for performing time series analysis.

Unsteady Flow See Flow, Steady and Unsteady.

Usable Area See Area, Usable.

Utilization Curves See Suitability Curves.

Variance The mean value of the square of the deviations of the sample values from their mean.

Variation Ratio The ratio of the 50–90% exceedence value (Q_{50}/Q_{90}), which should be ≥ 1.

Water Year 1 October through 30 September; usually considered to represent the annual hydrologic cycle beginning with that period of consistently low flows.

WATSTORE A data base of hydrologic information maintained by the USGS on a mainframe computer in Reston, Virginia.

Weighted Usable Area (WUA) See Area, Weighted Usable.

Weighting Factor The value that weights a surface area or volume regarding its suitability as habitat for a species or recreational activity.

Wet Season That period of a year that is characteristically wet (and having the greatest streamflows), implying an annual seasonal cycle.

Wet Year A water year characterized by above average discharge. Exact measure of deviation from some average, or median, value depends on the decision setting.

Year Class A cohort of organisms born within a specified calendar year (e.g., the 1986 year class; see Age Class).

NOTE: The mention of trade names does not constitute endorsement or recommendation for use by the Federal Government.

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